

Exhibit E

**IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NEW JERSEY**

**IN RE: JOHNSON & JOHNSON TALCUM
POWDER PRODUCTS MARKETING, SALES
PRACTICES AND PRODUCTS LIABILITY
LITIGATION**

MDL NO. 16-2738 (FLW) (LHG)

THIS DOCUMENT RELATES TO ALL CASES

**EXPERT REPORT OF LAURA WEBB, PHD
FOR GENERAL CAUSATION *DAUBERT* HEARING**

Date: February 25, 2019



Laura Webb, Ph.D.

Evaluation of the Formation of Talc Ores in the Fontane, Southern Vermont and Guangxi Talc Mines

1.0 Executive Summary

I have been asked to prepare a report focused on the scientific principles that govern the formation of mineable high-grade talc deposits used in the manufacture of Johnson's Baby Powder and Shower to Shower, and to investigate the possible relationship of such deposits, or lack thereof, to amphibole asbestos. This charge includes evaluating plaintiffs' experts' reports by Dr. Cook and Dr. Krekeler, and addressing differences in the formation of amphibole minerals with different crystal habits (e.g., asbestiform vs. prismatic) and the physical and chemical properties that impact biopersistence and toxicity.

Based on my review of materials, my educational background and professional experience as a geologist, my expert opinions are provided below with a reasonable degree of scientific certainty. My main conclusions are as follows:

A. Plaintiffs' experts' reports fail to appropriately synthesize key data and observations available in the peer-reviewed scientific literature that are pertinent to understanding the issues in this litigation. The body of evidence in the published scientific literature does not support the assertion that there is/was asbestos in cosmetic-grade talc deposits mined for use in Johnson's Baby Powder and Shower to Shower; nor do geologic principles suggest that there should be, based on a review of the local and regional geologic data.

B. Talc is a common metamorphic mineral in metamorphosed ultramafic and carbonate rocks. However, mineable high-purity talc deposits are the result of special cases of intense metasomatism (an uncommon form of metamorphism discussed below in Section 4.0) in which the chemical composition of an original rock is changed to something closer to that of the talc mineral composition. The conditions associated with this transformation to create the talc ores mined for Johnson's Baby Powder and Shower to Shower were not amenable to asbestos formation.

C. There is no well-founded, scientifically-sound evidence in the peer-reviewed scientific literature for an association of amphibole asbestos with the talc deposits of concern. Based on reviews of the geology associated with the applicable mines, and the pressure and temperature histories recorded by the rocks, any amphibole found in Johnson's Baby Powder and Shower to Shower derived from the Fontane, southern Vermont and Guangxi talc mines would likely be incidental actinolite or tremolite cleavage fragments from non-asbestiform amphiboles most likely derived from the margins (blackwall zones) of the talc deposits.

D. Amphibole cleavage fragments are, in general, much less chemically-resistant and have different surface chemistries than their asbestiform counterparts, for which other distinctive properties include flexible bundles of fibrils (typically less than 0.5 microns in diameter) with high tensile strength.

2.0 Summary of Qualifications

I am a geologist who specializes in using the tools of petrology (the origin and evolution of rocks discerned from mineralogical evidence), structural geology (interpreting rock deformation) and geochronology (radiometric dating) to understand the histories of rocks and regions. I obtained my Bachelor of Science in Geology from the University of California at Los Angeles in 1993 and my Ph.D. in Geological and Environmental sciences from Stanford University in 1999 (see CV attached as Exhibit A). After a postdoctoral appointment at the University of Geneva in Switzerland from 1999–2000, I moved to Syracuse University in New York, where I was a geochronology laboratory manager from 2000–2008 and held a Research Assistant Professor appointment from 2004–2012. In the fall of 2008, I began my career

at the University of Vermont (UVM) as a tenure-track faculty member in the Department of Geology. In 2014, I was promoted with tenure to Associate Professor. I am a member of the following professional societies: Geological Society of America, Mineralogical Society of America, American Geophysical Union, Vermont Geological Society and the American Association for the Advancement of Science.

Beginning with my early academic training as a geologist, I have worked extensively in regions with complex geologic histories, such as those in Italy, Vermont and China. Based on prior research projects and/or themes, I have familiarity with the regional geology of the Fontane and Guangxi mine regions and have experience working near the southern Vermont mines. I have (co)authored 33 peer-reviewed scientific papers (32 published and one currently in press) with an additional two manuscripts currently in revision or review. A common theme is the integration of microscopic-scale observations of the relationships between mineral growth and deformation with outcrop data and regional geological and geophysical data (e.g., Webb et al., 1999, 2010, 2014). These data facilitate understanding of the pressure-temperature-time-deformation history of rocks and the resulting implications for the tectonic evolution of regions. My teaching at UVM spans the scope of disciplines I employ in my research and includes those that are essential to a holistic understanding of the formation of talc deposits and assessing any possible relationship to asbestos. Such courses include Petrology, Microstructures, Geochronology and Tectonics.

I am being compensated at the rate of \$450 per hour for my expert work.

3.0 Minerals: Definitions and Important Concepts

Rocks are composed of one or more minerals. Minerals are naturally occurring inorganic compounds defined by their chemical compositions and unique crystalline structures. Minerals are classified based on these properties. In the case of talc deposits, geologists are mostly concerned with carbonate and silicate minerals that incorporate CO_2 and SiO_2 in their crystal structures. The mineral talc is a phyllosilicate (Figure 1), or sheet silicate, with the idealized chemical formula of $\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$.

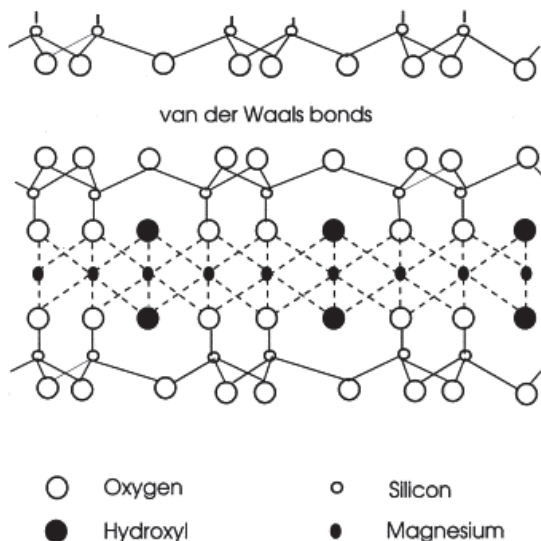


Figure 1. Ball and stick model of the crystal structure of the mineral talc (from Huang and Fuerstenau, 2001). Talc sheets consist of Si tetrahedral, Mg octahedral, and Si tetrahedral layers (T-O-T). Weak van der Waals bonds hold the T-O-T sheets together, giving talc its platy habit.

Many minerals can exhibit solid solution (i.e., be uniform solid mixtures), where cations (positively charged ions) with similar size and charge may substitute for one another in a mineral structure, allowing for known ranges in chemical composition for a given mineral. For example, forsterite is the pure magnesium-rich end-member of the mineral olivine (Mg_2SiO_4), and fayalite is the iron-rich end-member (Fe_2SiO_4). Almost all olivine found in nature contains some Fe and Mg and is thus a solid-solution of these two compositional end-members. Likewise, A small amount of Fe may substitute for Mg in talc crystals depending on various variables, including the chemistry of the geologic system and the pressure and temperature under which mineral formation and/or recrystallization occurs.

Structure and chemistry control all physical characteristics of a mineral, such as density, strength, mineral habit, cleavage, color and chemical stability. Habit is a term that refers to the general shape of the mineral, which is a function of the crystallographic structure as well as the conditions of formation. Table 1 defines common habit terms. Cleavage refers to weak planes in a crystal structure that influence how minerals break and controls the shape of crystal fragments. Cleavage planes may be described qualitatively as perfect, good, poor or indiscernible (synonyms may also be used). For example, talc crystals typically exhibit a platy or plate-like habit and have perfect cleavage along one crystallographic plane. This cleavage corresponds to the planes of weak van der Waals bonds (Figure 1). In other words, when forces are applied to talc crystals, the strongly-bonded T-O-T sheets remain intact and slip will occur along the weak forces of attraction between the sheets. This property is what gives talcum powders a slippery feel.

Table 1. Examples of common terms used to describe mineral habits.

Term	Definition
Acicular	Needle-like appearance, visible to naked eye.
Asbestiform	Having the habit of asbestos, including: "fiber-like morphology and dimensions; enhanced strength and flexibility; diameter-dependent strength; increased physical and chemical durability; and improved surface structure (i.e., relatively free of defects)." (NRC, 1984).
Bladed	Long, flat and thin.
Blocky or equant	Roughly equidimensional (e.g., boxy).
Fibrous	The appearance of clusters of minerals with long aspect ratios, often parallel to one another or radiating, that may or may not be separable. Often used synonymously with terms such as acicular, asbestiform and filiform.
Massive	No clear structure or dominant shape apparent.
Filiform or capillary	Thread-like appearance.
Platy	Sheet-like appearance.
Prismatic	Elongate with faceted sides.
Tabular	Having a rectangular shape and relatively thin or with moderate thickness.

Serpentine refers to a subgroup of phyllosilicates that includes about 20 minerals, including antigorite, chrysotile and lizardite (Rakovan, 2011). Serpentine minerals are 1:1 layer silicates. While the chemical formulas may be similar, Figure 2 illustrates how each has a unique crystal structure, making each a distinct mineral. Lizardite tends to most commonly occur as small (micron-scale) platy or elongate mineral



Figure 2. Schematic representations of the serpentine minerals (A) lizardite, (B) chrysotile, and (C) antigorite. Images from Lacinska et al. (2016). Tetrahedral layers are composed of silicon (Si) and oxygen (O), whereas the octahedral layers include magnesium (Mg), O, and hydrogen (H). While compositionally similar, the ways in which atoms are bonded result in varying crystal structures: flat lizardite sheets, cylindrical chrysotile, and modulated antigorite. A small mismatch in the size of the octahedral and tetrahedral sheets in chrysotile results in the mineral's characteristic cylindrical shape.

grains, antigorite tends to form coarser grained (millimeter-scale) flaky crystals, while chrysotile (serpentine asbestos) forms long hollow scrolls or cylinders with maximum outer diameters on the order of 150 angstroms (~0.015 microns) (Evans, 2004).

Amphibole minerals (Figure 3 [p. 5]) are members of the inosilicates that can exhibit a range of compositions (i.e., solid solution) (Table 2 [p. 6]). Which amphibole(s) are present in a rock (e.g., actinolite or anthophyllite) depend on the chemistry of the rock and its geologic history. Likewise, whether an amphibole is prismatic or asbestiform is strongly dependent on pressure and temperature, volume and composition of fluids and the deformation history of the rock at the time of its formation. Details relevant to these topics are discussed in subsequent sections of this report.

In cases where the amphibole crystal shape is well developed (i.e., prismatic), amphiboles are typically hexagonal in cross-section (Figure 3b). In general, amphiboles have two good cleavages that coincide with the {110} crystallographic planes (labeled in Figure 3b). Figure 3c illustrates how, in cross-section, these cleavage planes intersect in a diamond shape (see also upper left image in Figure 4 [p. 8]) and that the long axis of cleavage fragments are typically parallel to the c-axis of the mineral.¹

While asbestiform minerals may be called fibrous, fibrous is not exclusively synonymous with asbestiform. The term fibrous is frequently used many ways by scientists, often applied to mineral habits with long aspect ratios that range in form from bladed to acicular to asbestiform (Zoltai, 1978; Ross et al., 2008; Belluso et al., 2017). Several different regulatory definitions also exist and must be distinguished as such (see summary in Wylie and Candela, 2015). For example, elongate mineral particle (EMP) has been employed as a term encompassing all structures with aspect ratios greater than 3:1, and therefore does not discriminate between asbestos and cleavage fragments (Kelse and Thompson, 1989). To further confound the issue, while asbestiform-amphibole-bearing deposits or rock units may contain non-asbestiform amphiboles (e.g., Harper et al., 2015), it is not the case that non-asbestiform (i.e., common) amphibole-bearing rocks inherently contain asbestiform amphiboles.

In this report, I use the term amphibole asbestos to refer to the regulated forms of amphiboles² that grow in an asbestiform habit. Non-asbestiform amphiboles refer to all other habits, such as prismatic, acicular, bladed (note that the latter two terms may be used synonymously with fibrous by certain authors). The issue of how amphibole asbestos differs from non-asbestiform amphiboles is further addressed below.

[Figure 3 on next page]

¹ Three-dimensional objects are often described using x, y, z coordinates for three mutually-perpendicular axes. Minerals are described in terms of a, b and c axes because these axes have different angular relationships to one another in different crystal systems.

² Regulated amphiboles refer to asbestiform riebeckite (crocidolite), cummingtonite-grunerite (amosite), anthophyllite, tremolite and actinolite, for which federal standards exist for occupational exposure or product concentration limits.

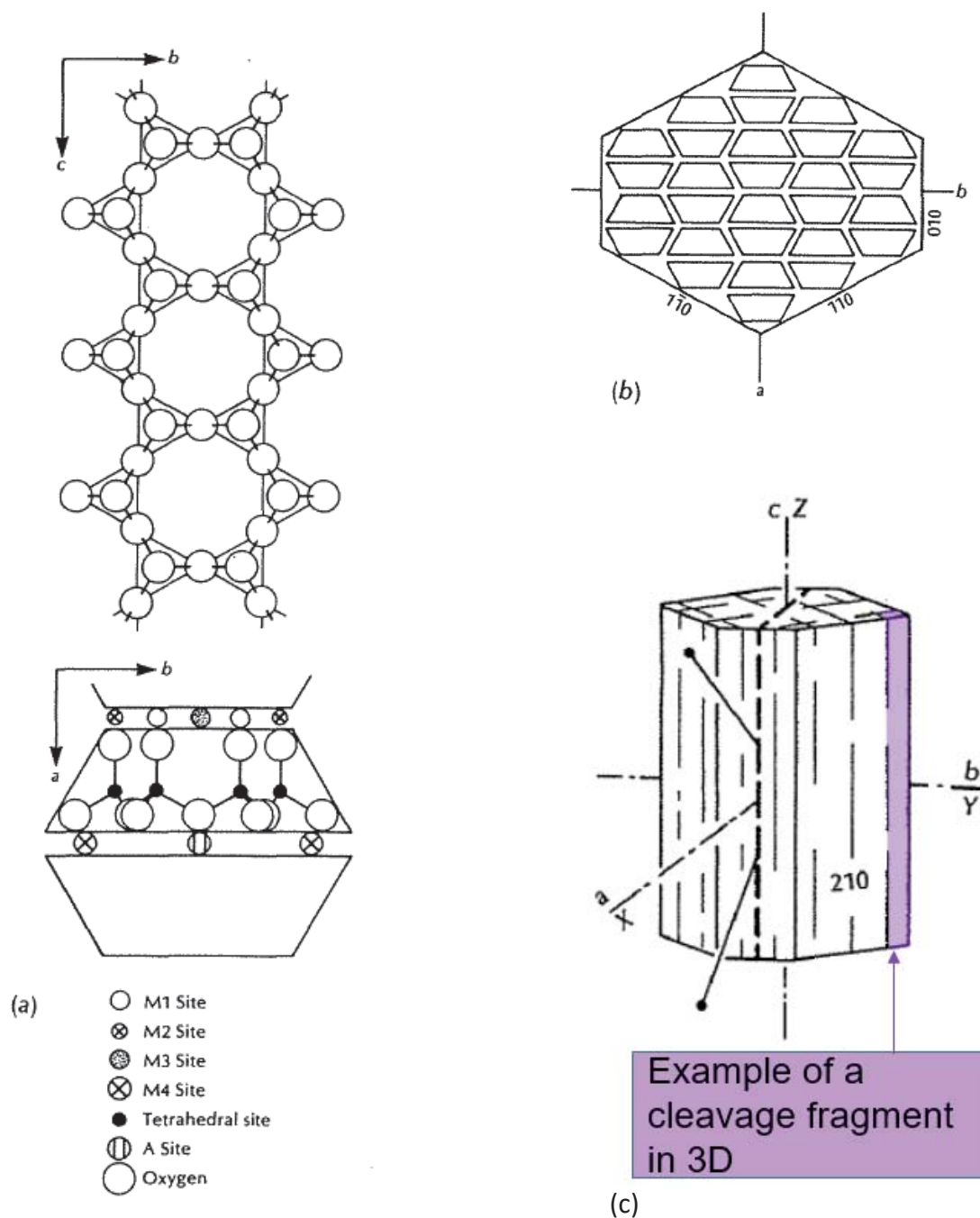


Figure 3. Generalized amphibole crystal structure from Nesse (1991). **a)** Idealized double chain of tetrahedral (Si, O). The M1, M2, and M3 lattice sites correspond to elements associated with 'Y' as listed in Table 2, which are in octahedral coordination. Octahedral coordination means an atom is bonded with six neighboring elements or groups of elements (6-fold), defining the vertices of an octahedron. The M4 site corresponds to the elements associated with 'X' as listed in Table 2, which are in either octahedral or cubic (8-fold) coordination. The A site is a vacancy (empty site) in the amphibole structure. **b)** View down the c-axis of the crystal showing a typical amphibole cross-section (hexagonal). Amphiboles have two perfect cleavages that correspond to the {110} planes, forming diamond shapes in cross-section due to intersections forming ~120° and 60° angles. **c)** Three-dimensional view of an amphibole (anthophyllite) with the idealized crystal shape, showing a possible cleavage fragment with diamond-shaped cross-section (top) and long axis parallel to c-axis of the mineral. Another perspective is shown in Figure 4.

Table 2. Chemical formulas for minerals referred to in this report.

Mineral	Formula
Talc	$\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$
<i>Serpentine Group</i>	$\text{D}_3[\text{Si}_2\text{O}_5](\text{OH})_4$ D= Mg, Fe, Ni, Mn, Al, Zn
Chrysotile & lizardite; antigorite	$\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$; $\text{Mg}_{48}\text{Si}_{34}\text{O}_{85}(\text{OH})_{62}$
<i>Amphibole group</i>	$\text{AX}_2\text{Y}_5((\text{Si}, \text{Al}, \text{Ti})_8\text{O}_{22})(\text{OH}, \text{F}, \text{Cl}, \text{O})_2$ A = □, Na, K, Ca, Pb^{2+} X = Li, Na, Mg, Fe^{2+} , Mn^{2+} , Ca Y = Li, Na, Mg, Fe^{2+} , Mn^{2+} , Zn, Co, Ni, Al, Fe^{3+} , Cr^{3+} , Mn^{3+} , V^{3+} , Ti, Zr □ = Vacancy: Empty A site in the amphibole structure
Riebeckite (crocidolite)	□ $\text{Na}_2(\text{Mg}, \text{Fe}^{2+})_3\text{Fe}^{3+}_2\text{Si}_8\text{O}_{22}(\text{OH})_2$
Cumingtonite-grunerite (amosite ^a)	□ $\text{Mg}_7\text{Si}_8\text{O}_{22}(\text{OH})_2$ to □ $\text{Fe}^{2+}_7\text{Si}_8\text{O}_{22}(\text{OH})_2$
Anthophyllite	□ $(\text{Mg}, \text{Fe}^{2+})_7\text{Si}_8\text{O}_{22}(\text{OH})_2$
Actinolite	□ $\text{Ca}_2(\text{Mg}, \text{Fe}^{2+})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$
Tremolite	□ $\text{Ca}_2(\text{Mg}, \text{Fe}^{2+})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$
Quartz	SiO_2
Sepiolite	$\text{Mg}_4(\text{Si}_6\text{O}_{15})(\text{OH})_2 \cdot (\text{H}_2\text{O})_6$
Forsterite (olivine; Mg-endmember)	Mg_2SiO_4
Enstatite (orthopyroxene; Mg-endmember)	MgSiO_3
Dolomite	$\text{CaMg}(\text{CO}_3)_2$
Calcite	$\text{Ca}(\text{CO}_3)$
Magnesite	$\text{Mg}(\text{CO}_3)$
Chlorite ^b	$\text{Mg}_5\text{Al}(\text{AlSi}_3\text{O}_{10})(\text{OH})_8$

^a Amosite is the commercial term for amphibole asbestos principally composed of grunerite asbestos, but known to contain small amounts of anthophyllite and actinolite asbestos (see Zoltai (1981) and Wylie (2016) and references therein).

^b Formula here is given for clinochlore, one of the most common members of the chlorite group; Fe^{2+} may substitute for Mg^{2+} , grading into the Fe-rich endmember, chamosite.

3.1 Asbestos

Dorling and Zussman (1987) documented four major types of habit exhibited by amphibole minerals, which include “massive, prismatic, finely acicular, and asbestos.” Prismatic and acicular habits are most common, and the asbestiform habit is very rare (Zoltai, 1979; Walker and Zoltai, 1979; Nesse, 1991; Klein, 1993; Veblen and Wylie, 1993). Amphiboles are estimated to compose ~2–5% of the Earth’s crust (Nesbitt and Young, 1984), making them the fifth-most-abundant mineral. By area, 6–10% of the rock types exposed at the surface in the coterminous United States are amphibole-bearing (Wylie and Candela, 2015). Zoltai (1979) estimates that *less than 1% by volume of all amphiboles* may have crystallized with the asbestiform habit, and Wylie and Candela (2015) estimate that less than 0.1% of amphibole-bearing rock underlying the coterminous United States contain asbestos. The rarity of asbestos indicates that special conditions are required for its formation.³

³ Asbestos is most typically found as veins in which fibers grew perpendicular to the host rock walls as “cross fibers” or (sub)parallel to them as “slip fibers” (Zoltai, 1981; Ross and Nolan, 2003; Evans, 2004). Veins, in general, are not

Indeed, amphibole asbestos and cleavage fragments are fundamentally different (Figure 4 [p. 8]). Structural differences internal to amphibole asbestos and non-asbestiform amphiboles include: 1) abundant twinning⁴ in asbestos compared to non-asbestiform amphiboles, and 2) abundant subgrains and dislocations⁵ in non-asbestiform amphiboles versus none in amphibole asbestos (Zoltai, 1981; Dorling and Zussman, 1987; Veblen and Wylie, 1993). Other key structural differences include the size, shape and surfaces of the grains themselves. When crushed, ground, etc. (communion), asbestos bundles break down into the individual fibrils (or smaller individual fibers), whereas non-asbestiform amphiboles tend to break along {110} cleavage planes. For this reason, the {110} plane is a common surface for (non-asbestiform) amphibole cleavage fragments (Figure 5 [p. 9]). In contrast, several authors have observed that amphibole asbestos fibrils commonly lie on surfaces that correspond to the {100} plane (Wylie, 1979, 2016; Dorling and Zussman, 1987; Brown and Gunter, 2003; Bandli and Gunter, 2014). In other words, amphibole cleavage fragments and amphibole asbestos, despite having the same mineral formula and same basic structure at the smallest scale, form in different ways and have different structural properties that control which crystallographic planes are typically exposed on their surfaces. In turn, because different crystallographic planes host specific elemental sites, which planes form mineral surfaces are significant factors in surface chemistry (Figure 5).

The differences described above influence particle size distributions observed for populations of mineral grains. Harper et al. (2008) demonstrated that width may be the most effective discriminator in size characterization studies of cleavage fragments versus asbestiform amphibole analogs. Fibril widths are typically less than 0.5 microns in diameter (Wylie and Candela, 2015; Wylie, 2016). Zoltai (1981) notes that if “fibers” are observed as single crystals (i.e., not associated with bundles) and have diameters larger than typical fibrils, they are capillary or filamentary crystals; strictly speaking, they are not asbestiform.

A key property of asbestos that made it commercially valuable is its high tensile strength and flexibility. This tensile strength is generally associated with low defect densities of fibril surfaces (Zoltai, 1981). Experiments have demonstrated that chemical resistance is a feature of the asbestiform habit, as explicitly noted in its definition, which is also attributed to the lower number of surface defects compared to non-asbestiform varieties (Walker and Zoltai, 1979; Gualtieri et al., 2018). Imperfections in the crystal structure due to deformation (i.e., dislocations or cleavage breaks) are known to be higher energy sites. Because the system wants to minimize its energy (see discussion of Gibbs free energy on p. 10), deformed regions of a crystal with structural imperfections are prone to faster dissolution rates (e.g., Schott et al., 1989; Lasaga and Lüttge, 2001). High densities of steps and kinks on mineral surfaces also show an effect of increasing dissolution rates (Arvidson et al., 2003). Steps and kinks are known to be common on growth

uncommon in nature but asbestos-bearing veins are. The minerals that crystallize in veins and their habits are ultimately controlled by the metamorphic and deformation environment (rock chemistries, pressure, temperature, fluid volume and chemistry, rock strength, stress field). Observations of asbestos crystal surfaces and morphology are consistent with laboratory experiments that indicate asbestos forms by rapid growth in a supersaturated fluid-filled medium (Dorling and Zussman, 1987). The implication is that asbestos nucleates on rock surfaces and grows in fluid fluid-filled fractures or other voids (Evans, 2004; Ross et al., 2008). This association of asbestos with voids, brittle faults, and fractures indicate that, in addition to fluid composition, low temperature and/or pressures conditions are important factors in its formation.

⁴ Twinning refers to symmetrical intergrowths within a larger crystal, where mirror images effectively occur across certain planes in the crystal lattice. In amphibole asbestos, twinning occurs along the {100} crystallographic plane shown in Figure 5.

⁵ Subgrains are domains within a crystal lattice that are slightly misoriented relative to neighboring domains. They are bound by dislocations, which are analogous to small faults or offsets in the crystal structure.

surfaces of prismatic or acicular amphiboles and their cleavage planes but are not commonly associated with their asbestiform counterparts (Dorling and Zussman, 1987). Furthermore, because cleavage fragments form due to rock deformation, either by tectonic processes or by crushing and grinding, they are likely to dissolve faster. As a result, amphibole asbestos is associated with more chemically resistant Fe-bearing surfaces that can catalyze reactions compared to non-asbestiform amphiboles.

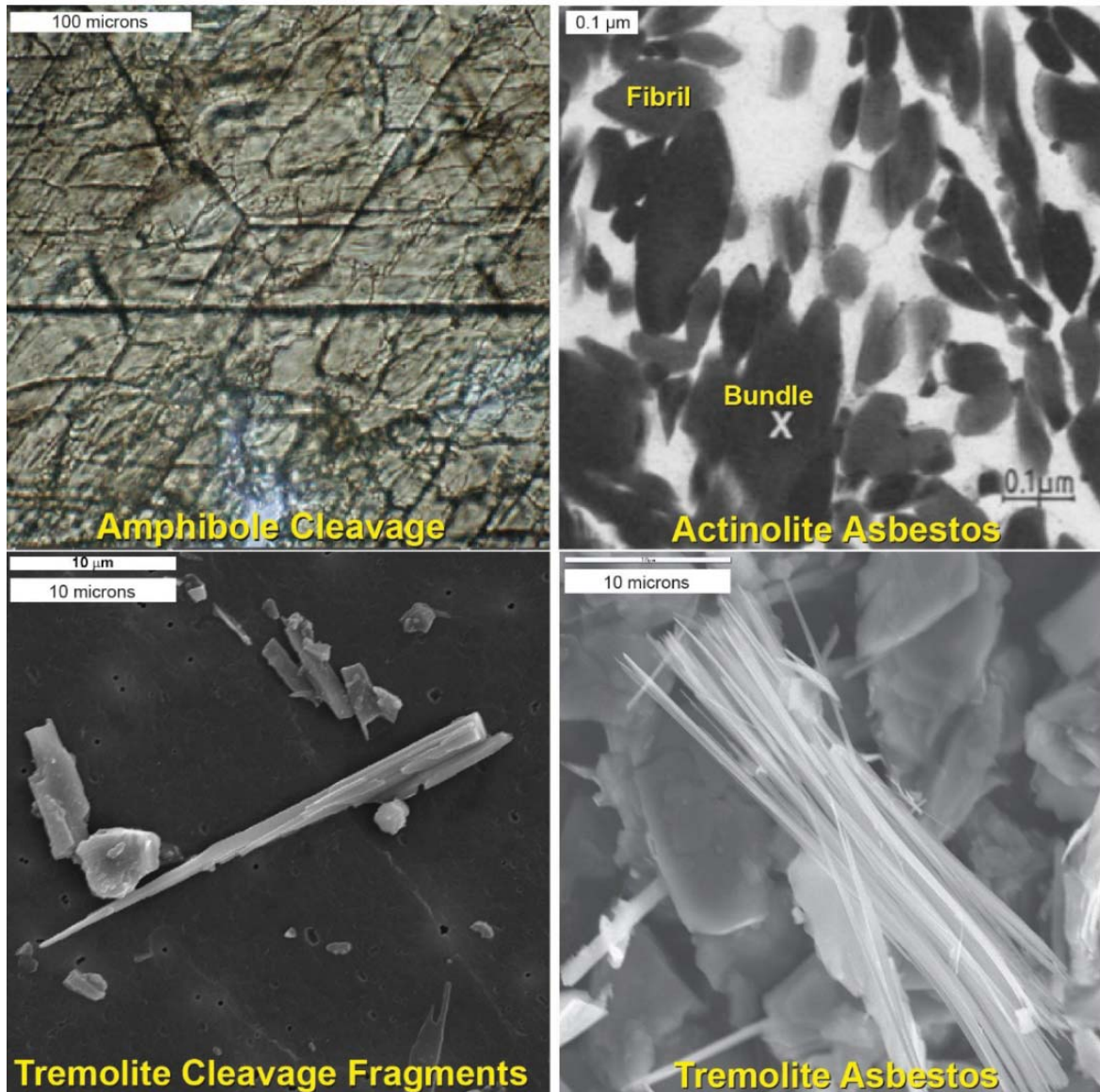


Figure 4. Images comparing amphibole cleavage and cleavage fragments with amphibole asbestos. Upper images show basal cross-section views (i.e., *a*–*b* plane in Figure 5). Upper-left image shows well-developed {110} cleavage planes (appearing as dark lines bounding diamond-shaped crystal volumes) seen in polarized light microscopy. Image from: <http://www.science.smith.edu/geosciences/petrology/petrography/hornblende/P1010004.jpg> Upper-right electron micrograph from Dorling and Zussman (1987) shows fibrils and fiber bundles. Fibrils are typically less than 0.1 microns in width, whereas bundles (example denoted by authors with an “x”) are larger clusters with more irregular outlines. Lower images show tremolite cleavage fragments and bundle(s) of tremolite asbestos fibrils taken with scanning electron microscopes (note similar scale of both images). Image on lower left is from <https://usgsprobe.cr.usgs.gov/images/hexagonite.jpg>; (hexagonite is a variety of tremolite). Image on lower right is from https://usgsprobe.cr.usgs.gov/images/asbestos_2.jpg.

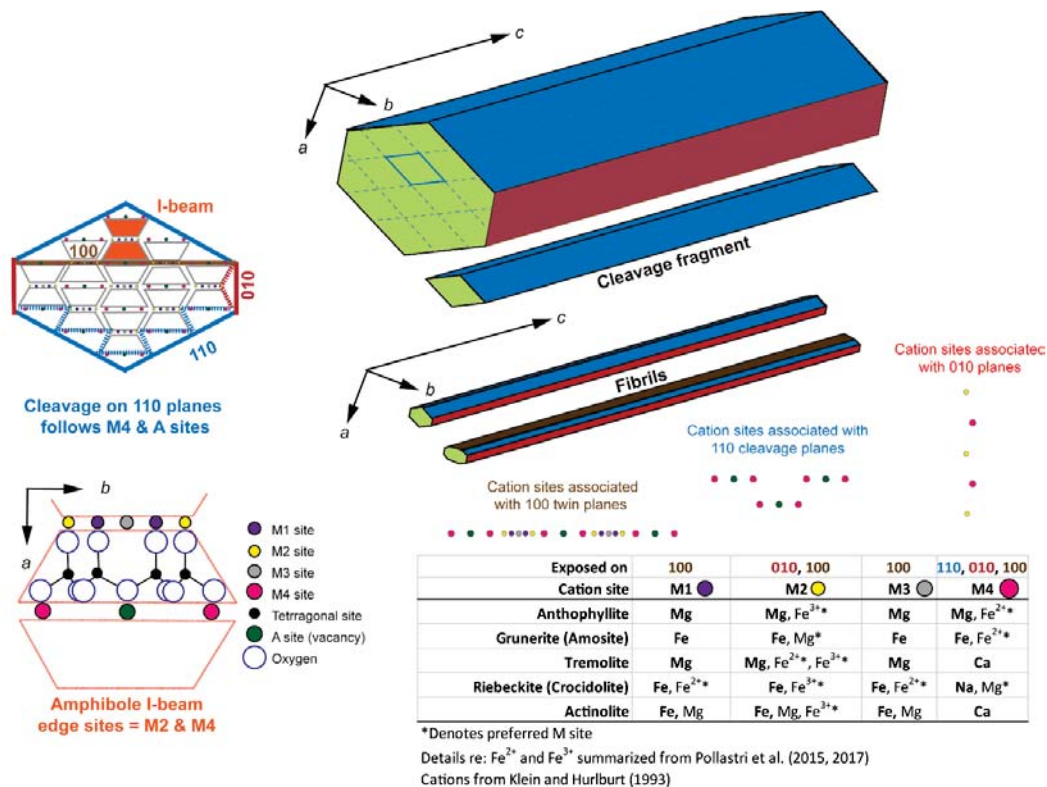


Figure 5. Diagrams depict differences between cleavage fragments and asbestos fibrils in terms of crystallographic planes that form surfaces. I-beams represent the fundamental double-chain strands in amphiboles. Cation sites associated with each surface are shown, which depends on the type of amphibole. Details regarding Fe²⁺ and Fe³⁺ in table summarized from Pollastri et al. (2015, 2017), and cations from Klein and Hurlburt (1993).

4.0 Formation of Talc Deposits: General principles of metamorphism and metasomatism

While talc is a common mineral in a variety of rocks, mineable cosmetic-grade⁶ talc deposits are rare and require special conditions for formation. General principles of petrology—the study of the composition, occurrence and origin of rocks—are critical to understanding the formation process described below. For the non-geologist, baking provides a good analogy. That is, what comes out of the oven specifically depends upon: 1) the *composition* of ingredients that are mixed and in what ratios; 2) the *temperature* of the oven; 3) the *time* spent in the oven; and 4) the atmospheric *pressure* (i.e., at sea level vs. high elevation). The science of petrology, therefore, can be thought of as the study of rock recipes. In nature, as in the kitchen, recipes can be scaled and the availability of some ingredients (or another resource, such as time) will be a limiting the factor in the volume of desired products that can be made.

Metamorphism is a process in which changes in mineralogy occur when a rock is exposed to temperatures, pressures and/or fluids different from the conditions under which it formed. The concept of metamorphism is critical to understanding the formation of talc deposits and, in the case of the deposits used in Johnson's Baby Powder and Shower to Shower, why asbestos is not associated.

⁶ Standards for cosmetic-grade talc include ≥ 90% mineralogical purity. (See Fiume et al., 2015).

When geologic conditions change, the atoms in a rock are reorganized into more stable configurations—mineral compositions, structures and assemblages—with a lower energy state. Metamorphism, by definition, involves solid-state chemical reactions that are dependent on the physical movement (diffusion) of chemical elements through a solid medium; fluids may or may not play a role and, generally, melt is absent except at very high temperatures (> 650 °C; 1202 °F). The laws of thermodynamics govern this process. Because metamorphism involves the diffusion of elements through solid crystal structures, lattice site by lattice site, or along grain boundaries, metamorphism typically occurs over geologic timescales (millions of years). High temperatures, the presence of fluids and deformation can enhance diffusion and thus recrystallization rates.

The term protolith refers to the original “parent rock,” the bulk composition⁷ of which has a primary control over the types and relative abundances of minerals that will comprise an equilibrium assemblage. An equilibrium assemblage is a combination of minerals that has the lowest possible Gibbs free energy⁸ given the pressure, temperature and bulk composition of the system. As noted earlier, Gibbs free energy is also associated with structural defects in crystal structures and grain boundary geometries within the rock. The more defects and the more convoluted the geometries, the higher the energy of the system and the higher the driving force for recrystallization. For a given bulk composition, the equilibrium assemblage is a function of the pressure and temperature conditions of metamorphism, often described as metamorphic facies (see Figure 6 and examples in figure caption).

There are three main different types of metamorphism, and they are not mutually exclusive. Regional metamorphism generally occurs during mountain building processes, referred to orogenesis, such as when continents collide. Contact metamorphism occurs more locally, possibly during regional metamorphism, due to juxtaposition of a hot magmatic intrusion with colder wall rocks. Hydrothermal fluids, possibly associated with magmatic intrusions, can also be a driver of metamorphism due to local interactions between hot ion-rich fluids and the wall rocks with which they interact.

The results of metamorphism depend on open vs. closed system behavior. In a closed system, there is no change in the overall composition of the rock, only the rearrangement of atoms into new minerals occurs. The baking analogy is you can only use the ingredients you have on hand in the kitchen. In contrast, in an open system, chemical components may be added or lost by a rock during metamorphism (i.e., you can borrow a cup of sugar or eggs from your neighbor). The metamorphic process can make as much of whatever the conditions allow, until the conditions change, or one of the necessary elements runs out.

The formation of talc deposits is the result of metasomatism, a special case of open-system metamorphism in which the bulk composition of a rock changes due to interactions with fluids and/or the transfer of elements between neighboring rocks. For example: **Rock A + Fluid = Rock B -or- Rock A + Rock B = Rock C + Rock D + ...** The degree to which chemicals are exchanged across a rock-fluid or rock-rock boundary and the width of the alteration zone are strongly dependent on temperature, time, the presence of fluids and the intensity of chemical gradients. The process can be further enhanced by deformation.

⁷ We can define the overall chemistry, or bulk composition, of a rock by major elements (> 2 wt. %), minor elements (2–0.1 wt. %) and trace elements (< 0.1 wt. %).

⁸ At a specified pressure and temperature, Gibbs free energy (G) can be defined as $G = H - TS$, where H is enthalpy, S is entropy and T is temperature in degrees Kelvin.

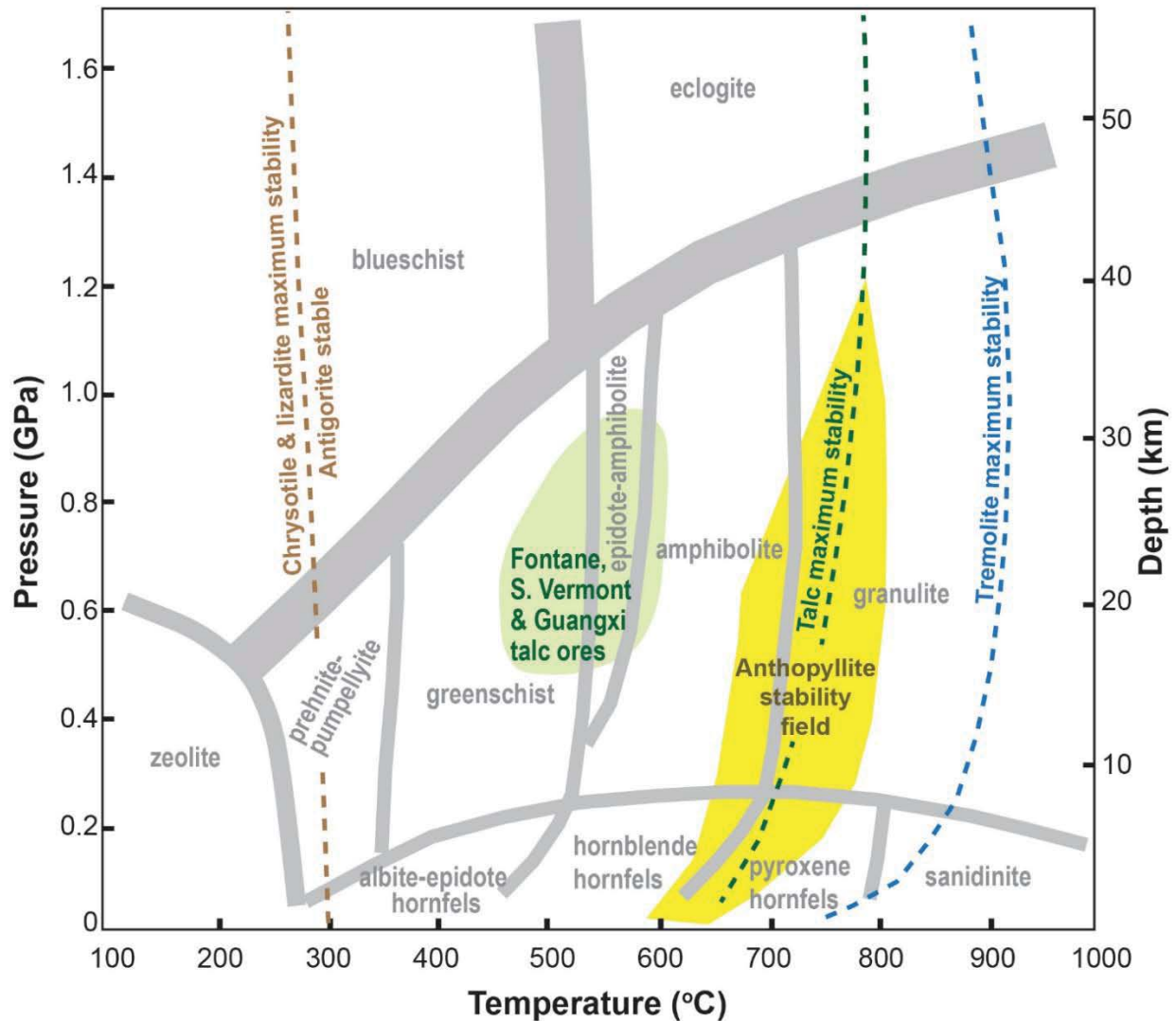


Figure 6. Pressure-temperature diagram modified from Winter (2001) showing in gray the general boundaries of different metamorphic facies (e.g., greenschist facies) that represent conditions under which certain combinations of minerals (i.e., equilibrium assemblages) are stable as a function of a rock's bulk composition. The diagram is appropriate for water-saturated ultramafic rocks (CaO-MgO-SiO₂-H₂O). For example, burial of rocks during regional metamorphism is typically associated with greenschist–amphibolite-facies metamorphism. Greenschist-facies metamorphism of mafic rocks (e.g., basalt) will tend to result in a mineral assemblage including chlorite + albite + epidote + actinolite + quartz, whereas amphibolite-facies metamorphism of mafic rocks is typically associated with the assemblage hornblende + plagioclase + quartz. Mineral stability fields for the serpentine minerals taken from Evans (2004). Stability field of talc, tremolite and anthophyllite from Winter (2001); see also discussion in section 5.2. The green shaded field shows the general pressure and temperature conditions attending talc ore formation from which Johnson's Baby Powder and Shower to Shower were sourced, as described in the text. Guangxi talc ores formed at greenschist facies, southern Vermont and Fontane talc ores at up to lower amphibolite facies. Note that conditions favoring asbestos formation are generally associated with low-temperature and/or low-pressure conditions (zeolite, prehnite-pumpellyite and hornfels facies).

4.1 A framework for analysis

By integrating observations made in the field and under the microscope with laboratory experiments, petrologists have constrained what minerals will form in a given rock type under different pressure and temperature conditions. Using this knowledge, we can either predict outcomes for different rock types (protoliths) and geologic histories or infer what the protolith and geologic history was based on observations of minerals and textures in rocks in the field and in petrographic thin sections.⁹

Figures 6 and 7 are examples of graphic representations petrologists employ to think about mineral assemblages and metamorphic reactions to constrain rock histories. For example, in Figure 6 above, the brown dashed line shows the stability fields of the different serpentine minerals as a function of pressure and temperature. Chrysotile and lizardite are stable (i.e., have the lowest Gibbs Free energy) at low temperatures, whereas antigorite is the most stable above ~300°C, depending on pressure. If we see chrysotile and lizardite veins in a serpentinite¹⁰, we can infer that those veins formed at low-temperature conditions. Likewise, the green dashed line represents the maximum stability of talc, where it starts to undergo a metamorphic reaction to form anthophyllite + quartz + water. If in a thin section we see talc texturally associated with anthophyllite and quartz, we can infer that the rock records a frozen metamorphic reaction¹¹ that occurred at granulite-facies conditions, or temperatures ~700°C. This inference would be strengthened if we saw granulite-facies mineral assemblages in neighboring rock types.¹² The yellow field represents the stability field of anthophyllite in ultramafic bulk compositions. Its presence in a rock would testify to the rock having experienced upper-amphibolite or granulite facies conditions. If the maximum metamorphic grade recorded by a suite of rocks is lower amphibolite facies conditions (i.e., maximum temperature is less than ~650°C), ultramafic rocks in that suite of rocks would not contain anthophyllite; they would instead contain tremolite.

Figure 7 shows a chemographic projection, which is basically a graphical expression of the proportions of chemical components in rocks and the minerals that comprise them. To use a chemographic projection, we need to decide what our most important ingredients are. For carbonate and ultramafic rocks, the key chemical components are CaO, SiO₂, and MgO, and they are assigned to the three apices of the triangle. We need to consider fluids such as water (H₂O) and carbon dioxide (CO₂) and decide if they are abundantly available or are a limited resource. In the case of Figure 7 and the discussion that follows, the premise is that they are freely available to participate in reactions.

To plot a mineral or rock on the chemographic diagram, one must first determine the relative proportions of the chemical components. The mineral quartz (Qtz), SiO₂, plots at the SiO₂ apex. In this case, the mineral shares the same formula as the chemical component and 100% of the chemical composition of quartz is SiO₂. In the case of talc (Tlc), which has the formula Mg₃Si₄O₁₀(OH)₂, the chemical proportions are 3 MgO to 4 SiO₂ to 1 H₂O. Since water is ignored in the plotting scheme, we normalize the other chemical components to 100% and talc is plotted as 43% MgO and 57% SiO₂, therefore lying in that relative position

⁹ A standard thin section is a polished 30-micron slice of a rock that can be examined using polarized light microscopy (petrographic microscope).

¹⁰ Serpentinite is a rock predominantly composed of serpentine minerals.

¹¹ Metamorphic reactions can be preserved in rocks for a variety of reasons. For example, a chemical component might be limited ("runs out") or because of the timescales needed for reactions to go to completion, exceed the timescale of metamorphism.

¹² Petrology is effectively a forensic science, and for this reason petrologists work with suites of rocks rather than a single specimen.

on the line connecting the MgO and SiO₂ apices. The mineral tremolite (Tr), Ca₂Mg₅Si₈O₂₂(OH)₂, has the relative proportions (ignoring water) of 2 CaO to 5 MgO to 8 SiO₂, or 13.3% CaO, 33.3% MgO, and 53.3% SiO₂. Therefore, tremolite plotted based on these proportions lies closest to the SiO₂ apex, next closest to the MgO apex, and farthest from the CaO apex.

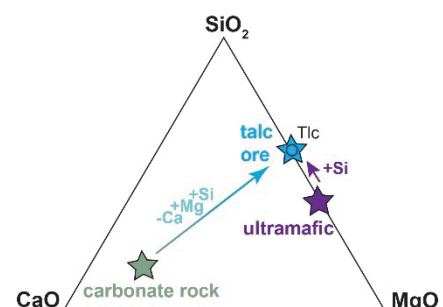
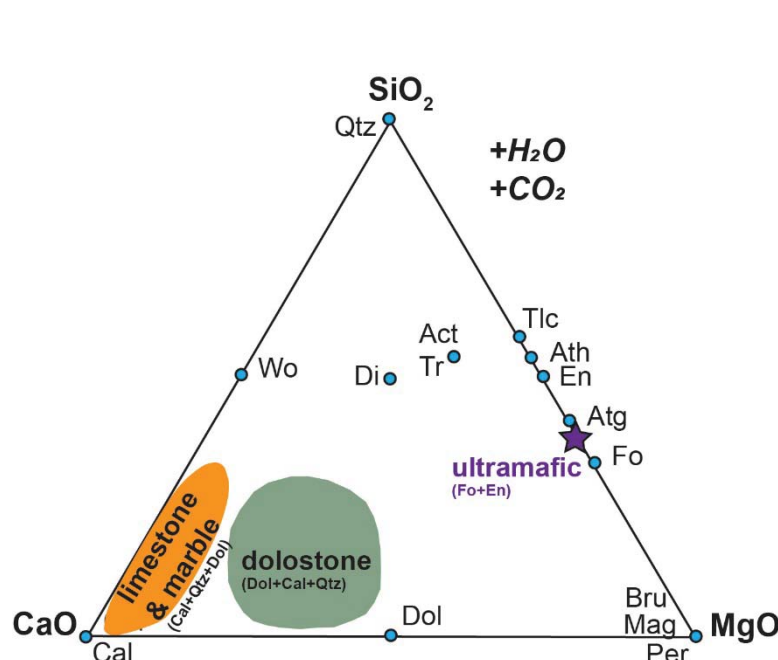


Figure 7. Chemographic diagrams for the CaO-SiO₂-MgO chemical system for calcareous and ultramafic rocks modified from Winter (2001). Plot on left-hand side shows where rocks and minerals plot based on their chemical composition. Because of solid solution (e.g., the ability for Fe to replace Mg in a crystal structure), mineral positions may vary slightly due to actual mineral composition. Here, actinolite plots with tremolite because this simplified plotting scheme does not account for Fe. Abbreviations are as follows: Qtz = quartz, Act = actinolite, Tr = tremolite, Sep = sepiolite, Tlc = talc, Ath = anthophyllite, En = enstatite, Atg = antigorite, Fo = Forsterite, Bru = brucite, Mag = magnesite, Per = periclase, Dol = dolomite, Cal = calcite, Wo = Wollastonite and Di = diopside. Diagram in upper-right illustrates examples of changes in bulk composition due to metasomatism (open system metamorphism) resulting in the formation of high-purity talc deposits. See section 4.1 for discussion.

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One can plot rocks on a chemographic diagram based on their bulk composition as well as the combinations of minerals resulting from metamorphic processes. The mineralogy of the rock, including the relative proportions of minerals, must obey the rules of mass balance. That is, the relative proportions of the minerals must be consistent with the bulk composition. For example, the purple star shows a typical bulk composition of an ultramafic rock, an Mg-rich rock derived from Earth's mantle, that is composed of the minerals forsterite (Fo) and enstatite (En) (Table 2). During metamorphism, if the system is closed, no change in bulk composition occurs because no chemical components are added or lost from the system—that is except for water, which is freely available in this case. Metamorphism of ultramafic rocks in the presence of water at temperatures below ~500°C (~932°F) results in the formation of serpentine minerals¹³, typically antigorite or lizardite depending on the temperature and pressure of metamorphism (Figure 6). Note that the mineral antigorite (Atg) plots very close to the purple star, as would lizardite. Based on the starting bulk composition, metamorphism in the presence of water would transform the ultramafic rock almost completely to antigorite at greenschist-facies conditions (~350–500°C; Figure 6), but there would have to be a little residual forsterite left in the rock because the bulk composition is richer in MgO than the mineral formula for antigorite (i.e., the excess MgO is manifest in preservation of some

¹³ This transformation of ultramafic rocks into a serpentine-dominated mineralogy is called serpentinization.

of the original olivine). Because calcium is an essential chemical component in the tremolite, we would not predict any tremolite to form during metamorphism given the bulk composition of the ultramafic rock as defined in this example.

In the case of an open system, where chemicals other than H₂O or CO₂ may be added or lost due to chemical exchange between rock units or the introduction of silica-rich fluids via shear zones, faults or fractures, a talc deposit may form. For this to occur, a significant amount of SiO₂ must be added to the ultramafic rock system, ultimately shifting the bulk composition of the rock represented by the purple star to the position of talc (Tlc) on the graph (Figure 7). Likewise, in the case of a carbonate-rich (Cal ± Dol) protolith, SiO₂ and MgO must be added to the system to make a high-purity talc deposit.

The above principles highlight the fact that, while talc is a common metamorphic mineral in metamorphosed ultramafic and carbonate rocks, mineable high-purity talc deposits are the result of rare instances of rather extreme metasomatism, in which the bulk composition of a protolith is changed to something effectively matching (or very close to) the talc mineral composition.

5.0 Evaluation of talc mines used in Johnson's Baby Powder and Shower to Shower

Because each talc deposit is unique, an overview of the formation of talc deposits mined for use in Johnson's Baby Powder and Shower to Shower follows for the Fontane (Italy), southern Vermont and Guangxi (China) mines.

5.1 Sources of data

For the summaries and opinions provided below, I relied on peer-reviewed, published scientific literature and the examination of *primary sources* of data and observations. I emphasize the latter because, as discussed below (e.g., Section 5.3), there has been a lot of misinformation. Articles relating to the specific mines from which talcum powders were derived are somewhat sparse. In all cases, I integrated regional studies to understand the broader context and metamorphic conditions associated with the formation of the talc deposits. My examination of reports outside of the peer reviewed literature was very limited. For Guangxi talc ores, I used company documents (e.g., IMERYS413792) to find descriptions of geologic formation names and locations, and then used that information to search the peer-reviewed literature for relevant articles. This also facilitated assessing consistency between company reports and published findings.

In the case of both the southern Vermont talc mines and Fontane talc mines in Italy, I examined reports by Dr. Pooley¹⁴ from the Department of Mineral Exploration at University College Cardiff in Wales. In my professional opinion, Dr. Pooley's reports are important records of data and observations that augment and are consistent with the published literature. Dr. Pooley sampled not only the talc ores, but representative samples of rock types included in and adjacent to the ore bodies. This sampling strategy is consistent with that required to understand the talc ores in the context of a geologic system and assess the potential for asbestos contamination. Based on my expertise, I focused on his petrographic thin section observations (polarized light microscopy) from which one can identify major, minor, and accessory minerals, their habits and their textural relationships (e.g., intergrowths, replacement textures, deformation at the microscale). I found his electron microscopy and X-ray diffraction data results to be consistent with the petrographic descriptions and photomicrographs.

¹⁴ The report titles include: *Talc Product Safety and Purity Project: 1. Talc Ore Sampling – Fontane Mine – Italy; Report of Italian Mine Samples J & J.; Report of the Examination of Rock Samples from the Vermont Mine.*

The summaries provided below emphasize findings from the published literature, noting consistency between the published data and that in the industry reports examined.

5.2 Talc from the Fontane talc mines, Val Germanasca, Italy

The Fontane Talc Mine workings are in Val Germanasca in the Pinerolo district of the Torino province of Italy. Cadoppi et al. (2016), Sandrone et al. (1990) and Sandrone and Zucchetti (1988) indicate that the Fontane talc bodies are embedded within a pre-Carboniferous (i.e., older than ~355 million years) polymetamorphic complex of the Dora Maira Massif (southern blue map unit in Figure 8). The talc ores are associated with layers of schist, marble, and gneiss (Del Greco and Pelizza, 1984; Cadoppi et al., 2016), corresponding to metamorphosed mudstone, limestone and basalt, respectively. The talc ore bodies are of high purity and confined to a sheet-like body with local impurities that include lenses of carbonate or schist of varying size (Del Greco and Pelizza, 1984; Sandrone and Zucchetti, 1988). Cadoppi et al. (2016) report that the processes leading to Fontane Talc mineralization are still debated. The talc formation is hypothesized by some to have resulted from regional metamorphism of an Mg-rich clay horizon such as sepiolite (Table 2; Figure 7) (Sandrone and Zucchetti, 1988). However, juxtaposition of carbonate rocks, schists, and metabasalts (the prefix “meta” means metamorphosed) as layers that host the talc ores, and the inclusion of these rock types locally within the talc ores, are consistent with a metasomatic origin (i.e., metasomatism of a carbonate rock to a talc ore; Figure 7).

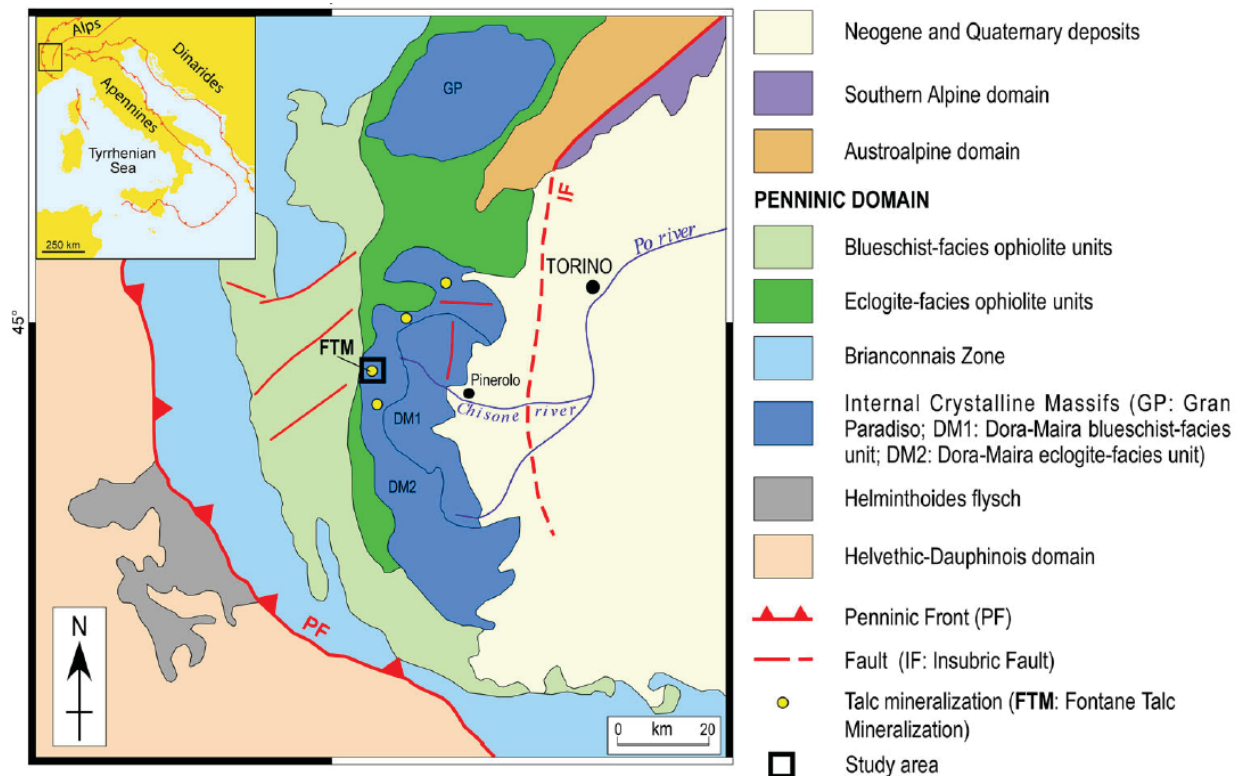


Figure 8. Map showing location of the Fontane talc mineralization (yellow dots) from Cadoppi et al. (2016). The Fontane talc mines (FTM) are hosted within the old, poly-metamorphosed continental crust of the Dora Maira unit. Note that this suite of rocks (blue) are in a different geologic unit than the ophiolite (oceanic crust and mantle) units (light and dark green), where asbestos has been documented. The tectonic juxtaposition of these map units post-dates the formation of the talc (see discussion in text).

The high-purity Fontane talc deposits formed early in the geologic history of the rocks and have been geologically stable since their formation. Integrated studies of metamorphism and deformation recorded by the talc ores and their host rocks indicate a complex polymetamorphic history in which the talc ores formed prior to the Cenozoic Alpine orogeny (i.e., the talc formed greater than ~60–35 million years ago) (Gasco et al., 2011; Cadoppi et al., 2016). Gasco et al. (2011) demonstrate that the rocks hosting the Fontane talc deposits, and thus the talc deposits themselves, never exceeded temperatures of ~575°C during the Alpine phases of metamorphism. This is important because studies have shown that talc, once formed, is stable up to at least 650°C (1202°F) and as high as 800°C (1472°F) depending on pressure (e.g., Pawley and Wood, 1995; see also Sandrone and Zucchetti, 1988, and references therein; Figure 6).

The formation and location of asbestos and talc in the western Alps are clearly separated in both space and time. Asbestos is well-documented in ophiolite (sections of oceanic crust and upper mantle, mainly mafic and ultramafic rocks) units in the Piemonte zone (Labagnara et al., 2013). However, the talc ore bodies have no relationship to the ophiolites nor any direct geologic contact with them. The juxtaposition of the ophiolites (green units) and the Dora Maira massif (blue unit) that hosts the talc ores is the result of the Alpine orogeny, which postdates the formation of the talc ores by hundreds of millions of years. While tremolite¹⁵ is documented in the literature in some rock types adjacent to talc ores, and occasionally found in rock fragments included within the talc ore bodies (Sandrone and Zucchetti, 1988; Cadoppi et al. 2016), there are no reports of asbestos associated with rock units in the Fontane talc mines in the published, peer-reviewed literature (nor detections of it in tests of Fontane mine-derived talcum powders; e.g., Marconi and Verdel, 1990).

The minerals and textures reported by Dr. Pooley for samples of the Italian mines are consistent with the geologic data and metamorphic histories documented by the publications cited above. Dr. Pooley examined more than 40 rock samples from a variety of rock types adjacent to the talc ores, as well as the talc ores themselves and specimens discarded during the screening stage. No asbestos or asbestiform minerals are reported. The only amphibole(s) observed are non-asbestiform calcic amphiboles, principally tremolite. The tremolite documented is prismatic, coarse-grained and bladed, occurring in surrounding rock types (his samples I19, I32, I35), which are locally found as rock inclusions in ore bodies. Only one talc ore sample revealed tremolite found as long prismatic inclusions in garnet (sample I41). (See JNJALC000165964; JNJALC000347819).

In summary, the Fontane talc mines are hosted within a metamorphosed suite of crustal rocks including mudstone, carbonate and basalt protoliths. Based on the rock-type associations, the talc ores formed from metasomatism of carbonate rocks juxtaposed with Si-rich metasedimentary and Mg-rich metabasalts (in the presence of H₂O and CO₂) at temperatures up to ~575°C. In contrast to plaintiffs' experts' claims, there is no record of asbestos having formed in these rocks; the geologic conditions were unfavorable. Rather, the occurrence of asbestos in the region is associated with unrelated and spatially distinct ophiolite units.

5.3 Talc from southern Vermont, USA

The Vermont talc mines used for Johnson's Baby Powder and Shower to Shower are near Ludlow, Vermont (Figure 9). These talc deposits formed via metasomatism during the Acadian orogeny (Late Devonian, ~380–360 million years ago) at the interface between Mg-rich ultramafic (mantle derived) rocks juxtaposed with Si-rich metasedimentary rocks (Chidester et al., 1951; Cady et al., 1963; Sanford, 1982;

¹⁵ Non-asbestiform tremolite.

Robinson et al., 2006). This metasomatic process is like that described in section 4.1 (i.e., metasomatism of ultramafic rock to talc). The age of the deposits was originally deduced from correlation of the foliations(s) exhibited by the talc deposit with those documented regionally, resulting from deformation during the Acadian orogeny.

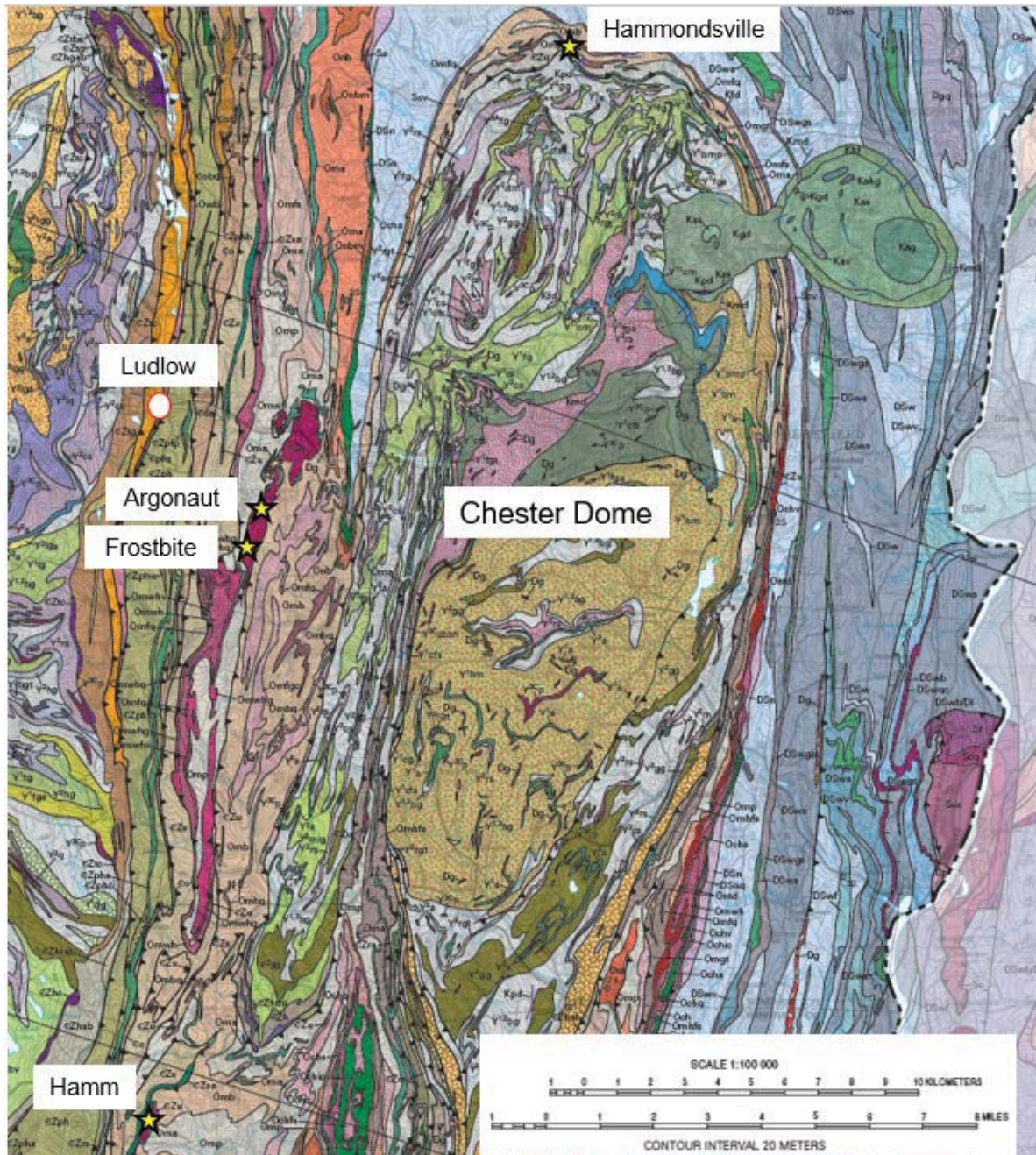


Figure 9. Location of talc mines in the Ludlow region of southern Vermont. Talc for Johnson's Baby Powder and Shower to Shower came from the Hammondsville, Hamm and Argonaut mines. The Frostbite mine is also discussed in the text. The mines are associated with ultramafic rock units distributed within the Moretown Formation along the northern and western edges of the Chester Dome. Bedrock Geologic Map of Vermont from Ratcliffe et al. (2011). The complete version of this map, including the detailed index of rock units and map symbols, can be found here: <https://dec.vermont.gov/geological-survey/publication-gis/VTrock>.

The most authoritative publication on the petrologic processes that control the formation of talc deposits associated with ultramafic bodies in southern Vermont is Sanford (1982). While Sanford (1982) did not study the Ludlow area deposits specifically, his case studies from Vermont and Massachusetts provide excellent context. Considered a classic, this work provides the basis for metamorphic petrology textbook discussions of the formation of talc deposits via metasomatism (e.g., Winter, 2001). Sanford's (1982) description of the Newfane quarry is an analog for the mines that produced cosmetic-grade talc based on the similarity in metamorphic conditions. Figures 10 and 11 show a chemographic diagram for the Frostbite mine in the Ludlow area as well as schematic representations of the mineralogical zonation resulting from metasomatism along the contact between an ultramafic body and metasedimentary country rocks. The diagram shown in Figure 11 is based on the Newfane quarry, located ~23 km (~14 mi) south of the Hamm mine and positioned similarly along the margin of the Chester dome. Depending on the bulk composition of the rock and the metamorphic grade, the amphiboles of note in rocks immediately adjacent to the talc ore are either actinolite or tremolite, with anthophyllite present only at the highest metamorphic grades (Sanford, 1982). More specifically, anthophyllite is predicted to form at $T \geq 650^{\circ}\text{C}$ (1202°F ; Figure 6), or upper amphibolite-facies conditions (Johannes, 1968). Such conditions are known to have been experienced in the core of the Chester Dome. Positioned along the flanks of the dome, the Hammondsville, Hamm and Argonaut Mines experienced *maximum* metamorphic conditions up to lower amphibolite-facies ($T \leq 600^{\circ}\text{C}$, or 1112°F) conditions based on the mapping of isograds¹⁶ in Doll et al. (1961) and Karabinos et al. (2010); therefore, amphiboles in the suite of rocks present at these mines are most likely either tremolite or actinolite, depending on the bulk composition (actinolite in more Fe-rich bulk compositions).¹⁷ The Hammondsville mine is documented by Gillson (1927) and Chidester et al. (1951). These authors noted coarse flaky talc, a lack of serpentinite, and only localized masses of actinolite, which would be derived from blackwall, or the margin of the silica-rich metasedimentary rocks juxtaposed with the ultramafic bodies (i.e., the edges of the mineable talc deposit).

As noted previously, Dr. Pooley sampled a variety of representative rock types in the southern Vermont mine. Data and observations presented in Dr. Pooley's report for the southern Vermont talc mine are consistent with Sanford's (1982) findings for the talc zone formation in rocks of the Newfane quarry, which experienced similar metamorphic pressures and temperatures as the Ludlow area mines. Pooley documented no asbestos and found actinolite present only locally (sample V9) at margins of the talc bodies. The actinolite shown in Pooley's photomicrograph is coarse-grained and prismatic, not asbestiform. The suite of minerals observed in the country rocks is consistent with those described above and shown in Figure 11. Dr. Pooley's data are also generally consistent with the findings of Robinson et al. (2006) for the Frostbite Mine—although the latter does not report any amphiboles.

[Figure 10 on next page]

¹⁶ Isograds are contours of equal metamorphic grade (i.e., demarcations of rocks that record similar pressures and temperatures of metamorphism based on their mineral assemblages).

¹⁷ Note that other biopyriboles (Thompson, 1978; Bozhilov, 2013) have been documented as a function of bulk composition and metamorphic history. For example, at the Newfane locality, the thin epidote zone on the margins of the talc deposit shown in Figure 11 is known to contain intergrowths of hornblende, cummingtonite, and biotite interpreted to represent frozen metamorphic reactions (Sanford, 1982).

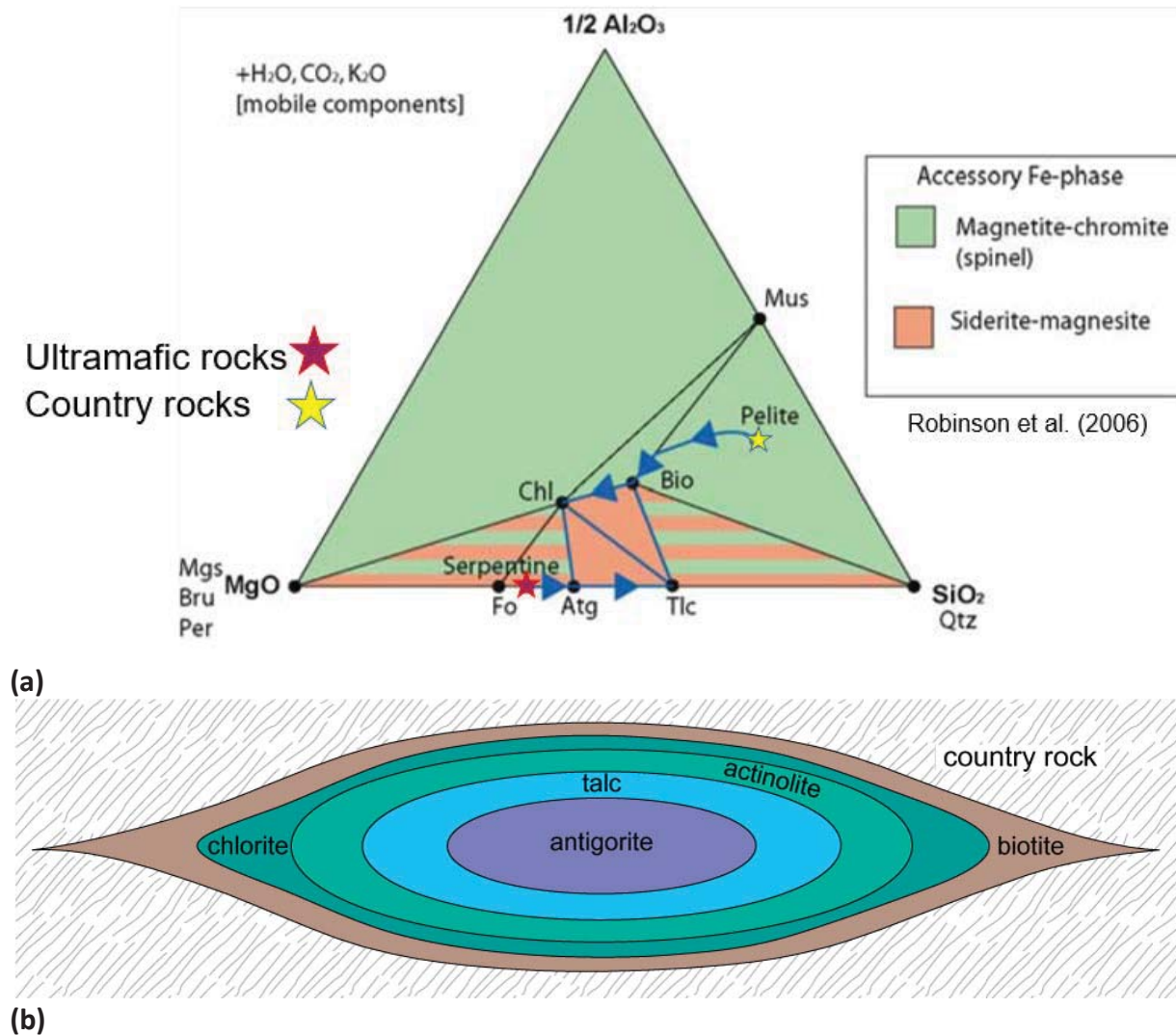


Figure 10. a.) Chemographic diagram for the Frostbite Mine modified from Robinson et al. (2006). The diagram illustrates the chemical exchange between Mg-rich ultramafic rock and the Si-rich metasedimentary country rocks that resulted in the formation of talc deposits and accounts for a slightly different chemical system than that in Figure 7. Migration of SiO_2 from the country rocks (pelite, or mudstone, is the sedimentary protolith) into the partially serpentinized ultramafic body moved its bulk composition towards talc to form the talc deposit. Migration of MgO from the ultramafic body into the country rocks moved that bulk composition towards chlorite to form the chlorite-rich blackwall zone. These metasomatic reactions created mineralogical zoning schematically shown in b. **b.)** Schematic diagram from Winter (2001) showing the idealized mineral zonation resulting from metasomatic reactions between ultramafic pods or lenses and metapelites during regional metamorphism.

[Figure 11 on next page]

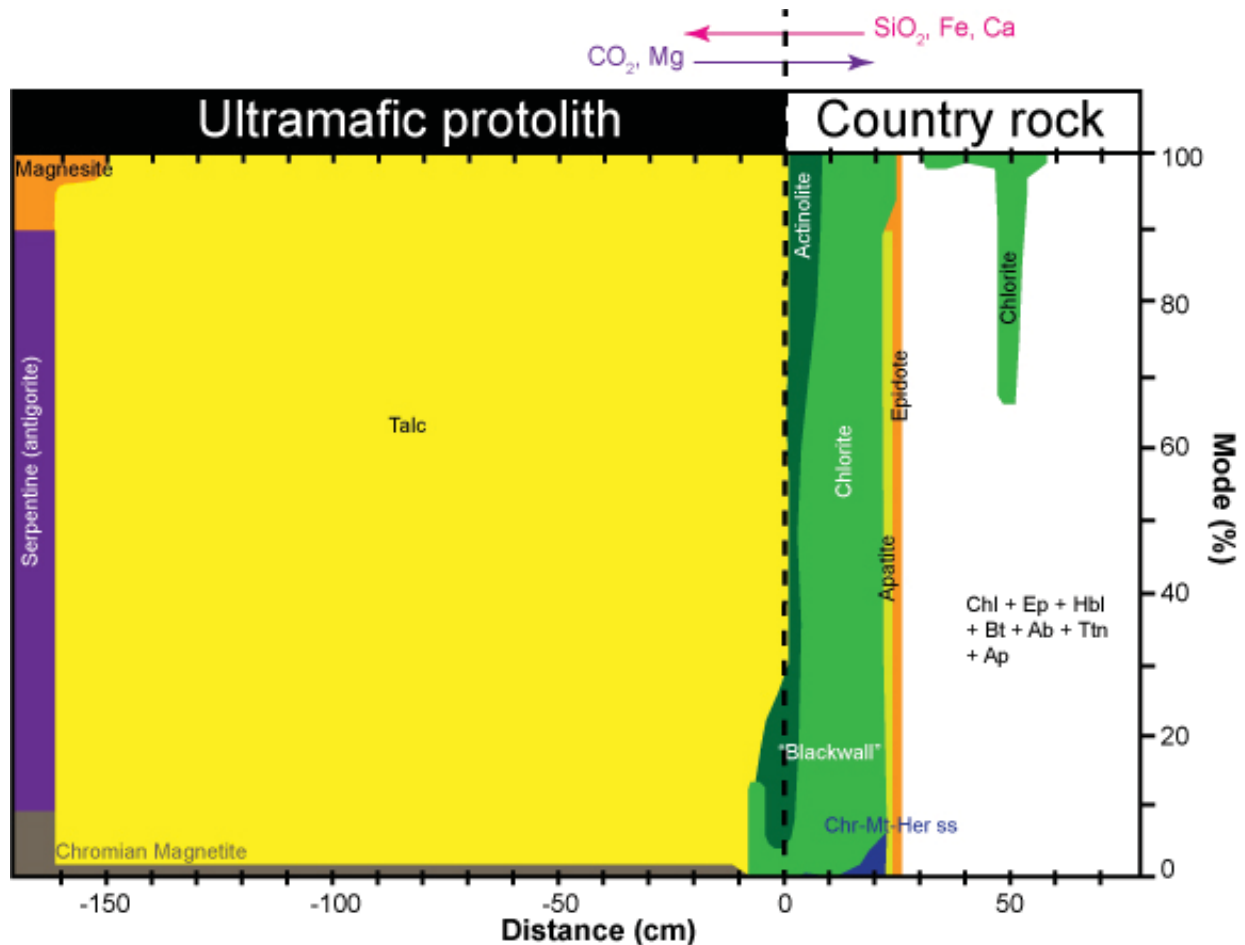


Figure 11. Diagram depicting mineralogical zonation resulting from metasomatism of an ultramafic body in contact with metasedimentary rocks. The X axis is distance measured in outcrop and the Y axis is modal percent, or the relative proportion of each mineral depicted or listed in the graph. The original contact between the ultramafic rocks and the metasedimentary rocks corresponds to 0 cm along the X axis; negative distance is associated with distance into the ultramafic body and positive distance is into the country rocks. Chemical fluxes (i.e., diffusion of Si into ultramafic body from the country rock), due to strong compositional differences between the rock types, are shown by the arrows at the top of the figure. The redistribution of chemicals and the recrystallization of the rocks results in the formation of distinct mineralogical zones during regional metamorphism. The diagram depicts the blackwall zone, which is the chlorite-rich zone (\pm actinolite) on the country rock-side of the lithologic contact. “Chr-Mt-Her ss” is chromite-magnetite-hercynite solid solution; “Chl + Ep + Hbl + Bt + Ab + Ttn + Ap” is the general country rock mineral assemblage of chlorite + epidote + hornblende + biotite + albite + titanite + apatite, which is indicative of epidote-amphibole-facies metamorphism.

Regional studies are clear that asbestos formation in Vermont occurred during a different tectonic cycle and under different metamorphic conditions than talc ore formation (~60 to 100 million years prior). Hess (1933) studied the occurrence of chrysotile asbestos in ~150 ultramafic bodies in the Appalachians from Alabama to Newfoundland, including those in Vermont, noting that in the bodies associated with talc deposits 1) serpentinization always preceded steatization¹⁸ and 2) that the chrysotile veins were

¹⁸ Steatization is a term used in the literature for the formation of talc-carbonate rocks from metasomatism, with the talc-carbonate rock sometimes being referred to as steatite or soapstone.

associated with the older serpentinization event and were limited spatially to the ultramafic body (i.e., were never found in the country rocks). Similar conclusions were made by Chidester et al. (1951), a study specific to Vermont talc, as well as Chidester et al. (1978). The latter study was specifically focused on the asbestos-bearing rocks around Belvidere Mountain in the northern Vermont talc belt. More recent work by Honsberger and Laird (2018) modeled the metamorphic histories of the Stockbridge and Belvidere ultramafic bodies and concluded there were two distinct events: 1) an earlier phase of metamorphism during which serpentinization occurred in the presence of H₂O (with chrysotile asbestos forming locally in the latter stages of this event); and 2) a later event associated with steatization in the presence of H₂O and CO₂-bearing fluids. In other words, all publications are consistent that talc ore formation was unrelated to the formation of asbestos and occurred under different metamorphic conditions.

There are limited publications implying that asbestos is commonly associated with the ultramafic rocks in the southern Vermont talc belt (Van Gosen et al., 2006). I have reviewed these papers and detail my professional opinion and findings below.

Van Gosen (2006) summarized reported asbestos deposits in the northeastern United States. Of the 22 localities listed in Vermont, the reports are mainly of chrysotile, with amphibole asbestos being much more limited. In southern Vermont, there are five reported asbestos localities, none of which were mined for talc for Johnson's Baby Powder and Shower to Shower, that can be considered generally in the vicinity of the Ludlow area mines:

1) The Five Corners Mine is located ~11 km (~7 mi) WNW of the nearest cosmetic-grade talc deposit at the Hammondsville Mine. There, tremolite asbestos is stated to occur in ultramafic rocks hosted in the Ottaquechee Formation based on Perry (1929). However, the report of asbestiform tremolite in Perry (1929) is tenuous because the description of the minerals is not consistent with the definition of asbestiform in Table 1. I found a brief reference to chrysotile in the Five Corners Mine in Chang et al. (1965), but this was not included in the Van Gosen (2006) summary; nor have I found any citations that corroborate this finding. I also note the country rocks that host the ultramafic rocks at the Five Corners Mine are a distinctly different geologic formation than those hosting the cosmetic-grade deposits used in Johnson's Baby Powder and Shower to Shower, which are hosted in the Moretown Formation (i.e., they are a different belt of rocks with a different tectonic history).

2) The Bridgewater Hill occurrence is cited as reported in Perry (1929). It is ~19 km (~12 mi) NW of the Hammondsville Mine. Perry (1929) only states that "asbestos" was found as a loose piece of rock in a pasture, but the specific mineralogy and/or context of its geologic occurrence is unknown. The country rock at this location is the Ottaquechee Formation, similar to that above for the Five Corners Mine.

3) Van Gosen (2006) notes a chrysotile occurrence in the Ludlow area, approximately ~2.4 km (~1.5 mi) NE of the Argonaut Mine, citing Chidester and Shride (1962) as cited in Van Gosen (2006). However, Chidester and Shride (1962) present no primary data or observations, and only cite Chidester et al. (1951) as their source. At issue here is the fact that Chidester et al. (1951) do not report any location information for their general report, making this reported locality impossible to evaluate.

4) Van Gosen (2006) indicates chrysotile is found in association with the Dover ultramafic body, which is ~27 km (~17 mi) SSE of the Hamm Mine. However, this occurrence is attributed to Chidester et al. (1951) and Chidester and Shride (1962). As noted above, the latter cites the former as its source of information and, once again, there is no documentation of asbestos in the Dover ultramafic body in Chidester et al. (1951).

5) The Chester Talc Mine, or Carlton Quarry, is listed in Van Gosen (2006) as an anthophyllite asbestos and possibly actinolite asbestos locality. The quarry is located ~10 km (~6 mi) NNE of the Hamm Mine and ~11 km (~7 mi) SSE of the Argonaut Mine. Again, Chidester et al. (1951) is cited as a source by Van Gosen (2006) but does not report asbestos at any specific locality. Another cited source, Gillson (1927), describes talc quarried here as low grade and suitable for some industrial purposes only. Two types of talc are noted: coarse flakes and fibrous pseudomorphs of actinolite; no asbestos is reported. Phillips and Hess (1936) describes needles of actinolite (i.e., acicular actinolite), some pseudomorphed by talc, but no asbestos. The occurrence of anthophyllite is summarized in Veblen and Burnham (1978). These authors describe complex intergrowths in the blackwall zone on the margin of the talc deposit where anthophyllite is replaced by intergrowths of chesterite, jimthompsonite, clinojimthompsonite and talc. Thus, the amphibole asbestos reported in Van Gosen (2006) is more consistent with “transitional” phases’ of Kelsey and Thompson (1989) rather than amphibole asbestos. The predominance of anthophyllite at this locality is consistent with the location’s position relative to mapped isograds (Doll et al., 1961; Karabinos et al., 2010), placing it at a higher metamorphic grade (higher temperature) than the cosmetic-grade deposits historically used in Johnson’s Baby Powder and Shower to Shower.

In short, the sources cited by Van Gosen (2006) as documenting asbestos occurrences in southern Vermont do not actually report asbestos at any specific locality, are based on ambiguous terminology and/or are inconsistent with other reports and publications. As noted in Bain (1942), while talc associated with ultramafic bodies in Vermont is common, only about a third of these occurrences are associated with “some fibrous magnesian mineral.” In other words, asbestos may occur locally, but is not ubiquitous to talc-bearing ultramafic rocks.

Plaintiffs also rely on the Blount (1991) paper, but that is problematic in several ways. The data upon which the conclusions are based are not presented, only interpretations. This would/should preclude publication in any reputable scientific journal because there is no way to evaluate or reanalyze the data, such as employing other plotting methods that have been determined to be more meaningful discriminators of asbestos versus cleavage fragments when looking at large populations of data (e.g., Wylie, 2016; Chatfield, 2018). Additionally, the methodology implied in Blount (1991) indicates Dr. Blount only counted particles with aspect ratios $\geq 3:1$ (as opposed to what is implied in Figure 6 from Blount (1991) for ‘Talc I’), whereas the frequency diagrams in Campbell (1977) include aspect ratios $< 3:1$. This effectively renders the comparison of the datasets incorrect, as it would impact binning intervals thus the frequency distributions. Furthermore, it is not clear how the “tremolite” particle in Blount (1991) Figure 5, presumably representing tremolite asbestos from Sample I, was determined to be tremolite. At a minimum, the refractive index used (1.584) would not distinguish tremolite from other amphiboles present (Crane, 1992) or other trace minerals with appropriate densities that could have been concentrated by Blount’s heavy liquid separation method. And finally, even Dr. Blount has questioned whether Sample I actually even came from Vermont.¹⁹

Overall, there are no data or observations, nor any petrologic argument, to support any claim of asbestos in the talc ores used in Johnson’s Baby Powder and Shower to Shower from southern Vermont. The plaintiffs’ experts’ reports fail to make the distinctions between some talc formed during serpentinization driven by hydration of the ultramafic rocks, in which chrysotile formed locally under low-temperature ($< 300^{\circ}\text{C}$) conditions, and talc ores that formed much later via metasomatism (in the presence of H_2O and CO_2) at medium pressure and higher temperatures ($\sim 500\text{--}600^{\circ}\text{C}$). They also accept at face value

¹⁹ Deposition of Alice M. Blount, Ph.D. in Gail Lucille Ingham and Robert Ingham, et al., v. Johnson & Johnson, et al., April 13, 2018, 52:9–53:21.

generalizations about the association of talc and amphibole asbestos made by Van Gosen et al. (2004) that are not representative of the talc ores mined for Johnson's Baby Powder and Shower to Shower, and fail to understand the details of the local and regional geology. The latter is apparent from 1) their assumption that all ultramafic rock bodies in Vermont have the same origin and similar history and 2) failure to recognize the complex distribution of rocks of different metamorphic grade resulting from multiple tectonic events.

5.4 Talc from the Guangxi Province in China

Little information is available in the peer-reviewed published literature on the talc deposits in the Guangxi Province in China. The geology of the Longsheng County talc mines of interest (Jizhua, Tongzishan, Guping and Shanglang mines) is deduced from Li (1979), Yao et al. (2016) and Zhao et al. (2018). The talc deposits are hosted in dolomitic marbles of the Hetong Formation in the Danzhou Group (Figure 12), which also includes metamorphosed sandstones and mudstones intercalated and intruded by mafic igneous rocks.

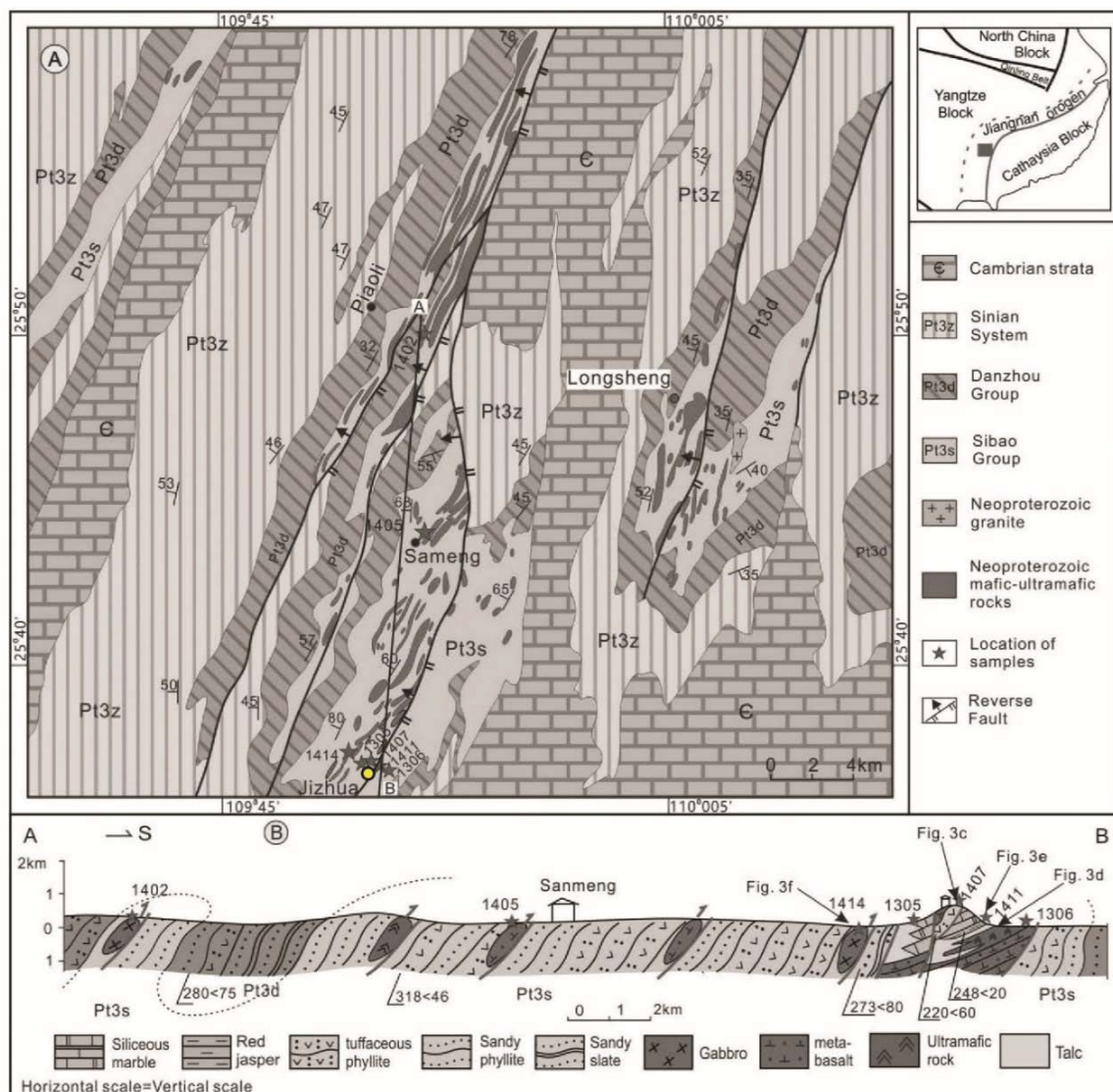


Figure 12. Geologic map from Yao et al. (2016) showing location of Jizhua (yellow dot) in Longsheng County, Guangxi Province, China. Talc deposits used in Johnson's Baby Powder and Shower to Shower are within the Danzhou Group.

Based on U-Pb zircon radiometric age constraints, the Danzhou Group was deposited sometime in the Neoproterozoic in a rift environment (Yao et al., 2016). Metamorphic mineral assemblages in the mafic rocks (e.g., albite, actinolite) indicate that the maximum grade of metamorphism experienced by the Danzhou Group hosting the talc deposits is greenschist-facies (medium pressure and maximum temperatures up to ~500°C; Figure 6). The talc deposits are spatially associated with thrust faults, including ductile shear zones, that formed during a collisional orogeny ~490–400 million years ago (Zhao et al., 2018). Deformation and metamorphism in the presence of Si-rich and H₂O and CO₂-bearing fluids facilitated metasomatism of the dolomitic marbles adjacent to the metabasalts to form the high-purity talc deposits (Li, 1979; Yao et al., 2016). Modeling of the metamorphic reactions indicates that some Mg needed to form the high-purity talc ores was supplied by the mafic rocks adjacent to the ore bodies (Li, 1979).

The descriptions of the geology and conditions of metamorphism in the published literature are consistent with that in the IMERYS413792 report for the Jizhua, Tongzishan, Guping, and Shanglang mines. While non-asbestiform tremolite and actinolite are reported in metabasalts (spillite) adjacent to the talc deposits by Li (1979) and IMERYS413792, respectively, none of the sources cited above detail any asbestiform minerals associated with the Longsheng talc deposits in the Danzhou Group, and there is no petrologic reason to predict the presence of asbestos.

6.0 Conclusions

Based on my knowledge of petrologic systems, extensive searching and evaluation of the published scientific literature, and examination of limited industry reports, it is my opinion to a reasonable degree of scientific certainty that the cosmetic talc sources used for Johnson's Baby Powder and Shower to Shower were limited to mines that were free of asbestiform minerals. Overwhelmingly, the data I have evaluated and described above weighs in favor of the conclusion that there is no scientific merit to any claims of asbestos in the cosmetic talc ores utilized. Based on reviews of the geology associated with the mines and the pressure and temperature histories recorded by the rocks, the amphiboles found in Johnson's Baby Powder and Shower to Shower derived from the Fontane, southern Vermont, and Guangxi talc mines would be incidental cleavage fragments from non-asbestiform amphiboles (i.e. prismatic or acicular), most likely derived from the margins (blackwall zones) of the talc deposits. Any such cleavage fragments are, in general, much less chemically-resistant and have different surface chemistries from their asbestiform counterparts, for which other distinctive properties include flexible bundles of fibrils with high tensile strength.

References Cited

- Andreozzi, G. B., Pacella, A., Corazzari, I., Tomatis, M., & Turci, F. (2017). Surface reactivity of amphibole asbestos: a comparison between crocidolite and tremolite. *Scientific Reports*, 7(1), 14696.
- Arvidson, R. S., Ertan, I. E., Amonette, J. E., & Luttge, A. (2003). Variation in calcite dissolution rates: A fundamental problem? *Geochimica et cosmochimica acta*, 67(9), 1623-1634.
- Bain, G. W. (1942). Vermont talc and asbestos deposits. *Ore deposits as related to structural features*. Princeton University Press, Princeton, New Jersey, 255-258.
- Bandli, B. R., & Gunter, M. E. (2014). Scanning electron microscopy and transmitted electron backscatter diffraction examination of asbestos standard reference materials, amphibole particles of differing morphology, and particle phase discrimination from talc ores. *Microscopy and Microanalysis*, 20(6), 1805-1816.
- Belluso, E., Cavallo, A., & Halterman, D. (2017). Crystal habit of mineral fibres. In *Mineral Fibres: Crystal Chemistry, Chemical-Physical Properties, Biological Interaction and Toxicity* (Vol. 18, pp. 65-109). European Mineralogical Union-EMU Notes in Mineralogy.
- Blount, A. M. (1991). Amphibole content of cosmetic and pharmaceutical talcs. *Environmental health perspectives*, 94, 225.
- Bozhilov, K. N. (2013). Structures and microstructures of non-classical pyriboles. *EMU Notes Mineral*, 14, 109-152.
- Brown, B. M., & Gunter, M. E. (2003). Morphological and optical characterization of amphiboles from Libby, Montana USA by spindle stage assisted-polarized light microscopy. *The Microscope*, 53(3), 121-140.
- Buzon, M. E. (2016). *Talc characterization: A provenance study*. University of Idaho.
- Cadoppi, P., Camanni, G., Balestro, G., & Perrone, G. (2016). Geology of the Fontane talc mineralization (Germanasca valley, Italian Western Alps). *Journal of Maps*, 12(5), 1170-1177.
- Cady, W. M., Albee, A. L., & Chidester, A. H. (1963). *Bedrock geology and asbestos deposits of the upper Missisquoi Valley and vicinity, Vermont* (No. 1122-B). US Geological Survey.
- Campbell, W. J. (1977). Identification of selected silicate minerals and their asbestiform varieties. *National Bureau of Standards, Special Publication*, 506, 201-221.
- Chang, P. H., Ern, H. Jr., Thompson, J.B. Jr. (1965). *Bedrock geology of the Woodstock quadrangle, Vermont*, 65 p., 2 plates.
- Chatfield, E. J. (2018). Measurement of elongate mineral particles: What we should measure and how do we do it? *Toxicology and applied pharmacology*, 361, 36-46.
- Chidester, A. H., Albee, A. L., & Cady, W. M. (1978). *Petrology, structure, and genesis of the asbestos-bearing ultramafic rocks of the Belvidere Mountain area in Vermont* (No. 1016). US Govt. Print. Off.

Chidester, A. H., Billings, M. P., & Cady, W. M. (1951). *Talc Investigations in Vermont Preliminary Report*. US Geological Survey.

Chidester, A. H., and Shride A. F. (1962). *Asbestos in the United States*, US Geological Survey. 12 pp.

Crane, D. T. (1992). *Polarized Light Microscopy of Asbestos*. Branch of Physical Measurements and Analysis OSHA Salt Lake Technical Center, Salt Lake City, Utah. Revised in 1995. <https://www.osha.gov/dts/sltc/methods/inorganic/id191/id191.html>

Del Greco, O., & Pelizza, S. (1984). The underground Fontane Talc Mine: main characteristics of the deposit and exploitation methods. *Bollettino dell'Associazione Mineraria Subalpina*, 21, 85-92.

Doll, C. G., Billings, M. P., Cady, W. M., & Thompson, J. B. (Eds.). (1961). *Centennial geologic map of Vermont*. Vermont Geological Survey, Vermont Development Department.

Dorling, M., & Zussman, J. (1987). Characteristics of asbestiform and non-asbestiform calcic amphiboles. *Lithos*, 20(6), 469-489.

Evans, B. W. (2004). The serpentinite multisystem revisited: chrysotile is metastable. *International Geology Review*, 46(6), 479-506.

Fiume, M. M., Boyer, I., Bergfeld, W. F., Belsito, D. V., Hill, R. A., Klaassen, C. D., ... & Snyder, P. W. (2015). Safety assessment of talc as used in cosmetics. *International journal of toxicology*, 34(1_suppl), 66S-129S.

Gasco, I., Borghi, A., & Gattiglio, M. (2011). P-T Alpine metamorphic evolution of the Monte Rosa nappe along the Piedmont Zone boundary (Gressoney Valley, NW Italy). *Lithos*, 127(1-2), 336-353.

Gillson, J. L. (1927). Origin of the Vermont talc deposits, with a discussion on the formation of talc in general. *Economic Geology*, 22(3), 246-287.

Gualtieri, A. F., Pollastri, S., Gandolfi, N. B., & Gualtieri, M. L. (2018). In vitro acellular dissolution of mineral fibres: A comparative study. *Scientific reports*, 8(1), 7071.

Harper, M. (2008). 10th Anniversary critical review: Naturally occurring asbestos. *Journal of Environmental Monitoring*, 10(12), 1394-1408.

Harper, M., Butler, C., Berry, D., & Wroble, J. (2015). Where occupation and environment overlap: US Forest Service worker exposure to Libby Amphibole fibers. *Journal of occupational and environmental hygiene*, 12(5), D47-D53.

Hess, H. H. (1933). The problem of serpentinization and the origin of certain chrysotile asbestos, talc, and soapstone deposits. *Economic Geology*, 28(7), 634-657.

Honsberger, I. W., & Laird, J. (2018). Net-Transfer Reactions and Modal Spaces for Ultramafic Slivers, Vermont Appalachians, USA. *The Canadian Mineralogist*, 56(5), 821-846.

Huang, P., & Fuerstenau, D. W. (2001). The effect of the adsorption of lead and cadmium ions on the interfacial behavior of quartz and talc. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 177(2-3), 147-156.

Karabinos, P., Mygatt, E. S., Cook, S. M., & Student, M. (2010). Evidence for an orogen-parallel, normal-sense shear zone around the Chester dome, Vermont: a possible template for gneiss dome formation in the New England Appalachians, USA. *From Rodinia to Pangea: The Lithotectonic Record of the Appalachian Region*. Edited by RP Tollo, MJ Bartholomew, JP Hibbard, and PM Karabinos. *Geological Society of America Memoir*, 206, 183-203.

Kelse, J. W., & Thompson, C. S. (1989). The regulatory and mineralogical definitions of asbestos and their impact on amphibole dust analysis. *American industrial hygiene association Journal*, 50(11), 613-622.

Klein, C. (193). Rocks, minerals and a dusty world. In: Guthrie, GD.; Mossman, B., editors. *Health effects of mineral dusts*. Washington, DC. p. 7-59.

Klein, C., & Hurlbut Jr, C. S. (1993). *Manual of Mineralogy*, 681 p.

Labagnara, D., Patrucco, M., Rossetti, P., & Pellegrino, V. (2013). Predictive assessment of the asbestos content in the Western Italian Alps: an essential tool for an effective approach to risk analysis and management in tunneling operations and muck reuse. *Environmental earth sciences*, 70(2), 857-868.

Lacinska, A. M., Styles, M. T., Bateman, K., Wagner, D., Hall, M. R., Gowing, C., & Brown, P. D. (2016). Acid-dissolution of antigorite, chrysotile and lizardite for ex situ carbon capture and storage by mineralisation. *Chemical Geology*, 437, 153-169.

Lasaga, A. C., & Luttge, A. (2001). Variation of crystal dissolution rate based on a dissolution stepwave model. *Science*, 291(5512), 2400-2404.

Li, Y. Y. (1979). Discussion on the genesis of Longsheng talc mine. *Non-Metallic Mines*, 1, 16-20

Marconi, A., & Verdel, U. (1990). Asbestos content of talcs from Italian mines and fibre concentration in various commercial talcum powders used in Italy. In *Health Related Effects of Phyllosilicates* (pp. 107-115). Springer, Berlin, Heidelberg.

National Research Council. (1984). *Asbestiform fibers: Nonoccupational health risks*. National Academies Press.

Nesbitt, H. W., & Young, G. M. (1984). Prediction of some weathering trends of plutonic and volcanic rocks based on thermodynamic and kinetic considerations. *Geochimica et Cosmochimica Acta*, 48(7), 1523-1534.

Nesse, W. D. (1991). *Introduction to Optical Mineralogy*: Oxford Univ. Press, 335.

Pawley, A. R., & Wood, B. J. (1995). The high-pressure stability of talc and 10 Å phase: potential storage sites for H₂O in subduction zones. *American Mineralogist*, 80(9-10), 998-1003.

Perry, E.L. (1929). *The geology of Bridgewater and Plymouth Townships, Vermont*, in Report of the state geologist on the mineral industries and geology of Vermont, 1927-1928: Burlington, Vt., Free Press Printing Co., p. 1-64.

Phillips, A. H., Hess, H. H. (1936). Metamorphic differentiation at contacts between serpentinite and siliceous country rocks. *Amer. miner.* 21, 333-62.

Pollastri, S., D'Acapito, F., Trapananti, A., Colantoni, I., Andreozzi, G. B., & Gualtieri, A. F. (2015). The chemical environment of iron in mineral fibres. A combined X-ray absorption and Mössbauer spectroscopic study. *Journal of hazardous materials*, 298, 282-293.

Pollastri, S., Gigli, L., Ferretti, P., Andreozzi, G. B., Gandolfi, N. B., Pollok, K., & Gualtieri, A. F. (2017). The crystal structure of mineral fibres. 3. Actinolite asbestos. *Periodico di Mineralogia*, 86(2), 89-98.

Rabbitt, J. C. (1948). A new study of the anthophyllite series. *American Mineralogist: Journal of Earth and Planetary Materials*, 33(5-6), 263-323.

Rakovan, J. (2011). Word to the Wise: Serpentine, California's State Rock. *Rocks & Minerals*, 86(1), 63-68.

Ratcliffe, N. M., Stanley, R. S., Gale, M. H., Thompson, P. J., Walsh, G. J., Rankin, D. W., Doolan, B. L., Kim, J., Merhtens, C. J., Aleinikoff, J. N., & McHone, J. G. (2011). *Bedrock geologic map of Vermont* (No. 3184). US Geological Survey.

Robinson, G. R., Van Gosen, B. S., & Foley, N. K. (2006). *Ultramafic-hosted Talc-Magnesite deposits*. US Geological Survey.

Ross, M., Langer, A. M., Nord, G. L., Nolan, R. P., Lee, R. J., Van Orden, D., & Addison, J. (2008). The mineral nature of asbestos. *Regulatory Toxicology and Pharmacology*, 52(1), S26-S30.

Ross, M., & Nolan, R. P. (2003). History of asbestos discovery and use and asbestos-related disease in context with the occurrence of asbestos within ophiolite complexes. *Special Papers-Geological Society of America*, 447-470.

Sandrone, R., Borghi, A., Carosso, G., Morsetti, C., Tagliano, C., & Zucchetti, S. (1990). Geometry of the talc deposit of Fontane, and structural evolution of the area (Dora-Maira Massif, Western Alps). *Bollettino Associazione Mineraria Subalpina*, 27, 45-62.

Sandrone, R., & Zucchetti, S. (1988). Geology of the Italian high-quality cosmetic talc from the Pinerolo district (Western Alps). In *Proceedings of Symposium "Zuffardi'days", Cagliari*.

Sanford, R. F. (1982). Growth of ultramafic reaction zones in greenschist to amphibolite facies metamorphism. *American Journal of Science*, 282(5), 543-616.

Schott, J., Brantley, S., Crerar, D., Guy, C., Borcsik, M., & Willaime, C. (1989). Dissolution kinetics of strained calcite. *Geochimica et Cosmochimica Acta*, 53(2), 373-382.

Thompson Jr, J. B. (1970). Recent discussions of pyroxenes and amphiboles-Abstracts. *American Mineralogist*, 55(1-2), 292-297.

Thompson, J. B. (1978). Biopyriboles and polysomatic series. *American Mineralogist*, 63(3-4), 239-249.

Van Gosen et al. (2004). Using the geologic setting of talc deposits as an indicator of amphibole asbestos content. *Environmental Geology*. 45:920-939.

- Van Gosen, B. S. (2006). *Reported historic asbestos mines, historic asbestos prospects, and natural asbestos occurrences in the Eastern United States* U.S. Geological Survey Open-File Report (No. 2005–1189) 1 plate. Includes supplementary materials. <https://pubs.usgs.gov/of/2005/1189/>.
- Veblen, D. R. (1991). Polysomatism and polysomatic series; a review and applications. *American Mineralogist*, 76(5-6), 801-826.
- Veblen, D. R., & Burnham, C. W. (1978). New biopyriboles from Chester, Vermont; I, Descriptive mineralogy. *American Mineralogist*, 63(9-10), 1000-1009.
- Veblen, D. R., & Wylie, A. G. (1993). Mineralogy of amphiboles and 1:1 layer silicates. Mineralogical Society of America *Reviews in Mineralogy*, 28, Washington, DC (United States).
- Walker, J. S., & Zoltai, T. (1979). A comparison of asbestos fibers with synthetic crystals known as “whiskers”. *Annals of the New York Academy of Sciences*, 330(1), 687-704.
- Webb, L. E., Baldwin, S. L., & Fitzgerald, P. G. (2014). The Early-Middle Miocene subduction complex of the Louisiade Archipelago, southern margin of the Woodlark Rift. *Geochemistry, Geophysics, Geosystems*, 15(10), 4024-4046.
- Webb, L. E., Johnson, C. L., & Minjin, C. (2010). Late Triassic sinistral shear in the East Gobi fault zone, Mongolia. *Tectonophysics*, 495(3-4), 246-255.
- Webb, L. E., Hacker, B. R., Ratschbacher, L., McWilliams, M. O., & Dong, S. (1999). Thermochronologic constraints on deformation and cooling history of high-and ultrahigh-pressure rocks in the Qinling-Dabie orogen, eastern China. *Tectonics*, 18(4), 621-638.
- Winter, J.D., 2001, *An Introduction to Igneous and Metamorphic Petrology*. Prentice Hall
- Wylie, A. G. (1979). Fiber length and aspect ratio of some selected asbestos samples. *Annals of the New York Academy of Sciences*, 330(1), 605-610.
- Wylie, A. G. (2016). Amphibole Dusts: Fibers, Fragments, and Mesothelioma. *The Canadian Mineralogist*, 54(6), 1403-1435.
- Wylie, A. G., & Candela, P. A. (2015). Methodologies for determining the sources, characteristics, distribution, and abundance of asbestiform and nonasbestiform amphibole and serpentine in ambient air and water. *Journal of Toxicology and Environmental Health, Part B*, 18(1), 1-42.
- Wylie, A. G., & Candela, P. A. (2015). Methodologies for determining the sources, characteristics, distribution, and abundance of asbestiform and nonasbestiform amphibole and serpentine in ambient air and water. *Journal of Toxicology and Environmental Health, Part B*, 18(1), 1-42.
- Yao, J., Cawood, P. A., Shu, L., Santosh, M., & Li, J. (2016). An early Neoproterozoic accretionary prism ophiolitic mélange from the western Jiangnan Orogenic Belt, South China. *The Journal of Geology*, 124(5), 587-601.

Zhao, Z., Xu, Z., Ma, X., Liang, F., & Guo, P. (2018). Neoproterozoic–Early Paleozoic Tectonic Evolution of the South China Craton: New Insights from the Polyphase Deformation in the Southwestern Jiangnan Orogen. *Acta Geologica Sinica-English Edition*, 92(5), 1700-1727.

Zoltai, T. (1978). History of asbestos-related mineralogical terminology. In *Workshop on Asbestos: Definitions and Measurement Methods. National Bureau of Standards, Special Publication* (Vol. 506, pp. 1-18).

Zoltai, T. (1979). Asbestiform and acicular mineral fragments. *Annals of the New York Academy of Sciences*, 330(1), 621-643.

Zoltai, T. (1981). Amphibole asbestos mineralogy. *Reviews in Mineralogy and Geochemistry*, 9(1), 237-278.

Materials Considered

Armstrong, T. R., & Tracy, R. J. (2000). One-dimensional thermal modelling of Acadian metamorphism in southern Vermont, USA. *Journal of Metamorphic Geology*, 18(6), 625-638.

Arvidson, R. S., Ertan, I. E., Amonette, J. E., & Luttge, A. (2003). Variation in calcite dissolution rates: A fundamental problem? *Geochimica et cosmochimica acta*, 67(9), 1623-1634.

Aust, A. E., Cook, P. M., & Dodson, R. F. (2011). Morphological and chemical mechanisms of elongated mineral particle toxicities. *Journal of Toxicology and Environmental Health, Part B*, 14(1-4), 40-75.

Bain, G. W. (1934). Serpentinization, origin of certain asbestos, talc, and soapstone deposits; discussion. *Economic Geology*, 29(4), 397-400.

Bain, G. W. (1936). Serpentinization of Vermont Ultrabasics. *Bulletin of the Geological Society of America*, 47(12), 1961-1980.

Bain, G. W. (1942). Vermont talc and asbestos deposits. *Ore deposits as related to structural features*. Princeton University Press, Princeton, New Jersey, 255-258.

Bandli, B. R., & Gunter, M. E. (2014). Scanning electron microscopy and transmitted electron backscatter diffraction examination of asbestos standard reference materials, amphibole particles of differing morphology, and particle phase discrimination from talc ores. *Microscopy and Microanalysis*, 20(6), 1805-1816.

Baronnet, A., & Belluso, E. (2002). Microstructures of the silicates: key information about mineral reactions and a link with the Earth and materials sciences. *Mineralogical Magazine*, 66(5), 709-732.

Belluso, E., Cavallo, A., & Halterman, D. (2017). Crystal habit of mineral fibres. In *Mineral Fibres: Crystal Chemistry, Chemical-Physical Properties, Biological Interaction and Toxicity* (Vol. 18, pp. 65-109). European Mineralogical Union-EMU Notes in Mineralogy.

Berner, R. A., & Schott, J. (1982). Mechanism of pyroxene and amphibole weathering; II, Observations of soil grains. *American Journal of Science*, 282(8), 1214-1231.

Blount, A. M. (1991). Amphibole content of cosmetic and pharmaceutical talcs. *Environmental health perspectives*, 94, 225.

Bozhilov, K. N. (2013). Structures and microstructures of non-classical pyriboles. *EMU Notes Mineral*, 14, 109-152.

Brown, B. M., & Gunter, M. E. (2003). Morphological and optical characterization of amphiboles from Libby, Montana USA by spindle stage assisted-polarized light microscopy. *The Microscope*, 53(3), 121-140.

Buzon, M. E. (2016). *Talc characterization: A provenance study*. University of Idaho.

Cadoppi, P., Camanni, G., Balestro, G., & Perrone, G. (2016). Geology of the Fontane talc mineralization (Germanasca valley, Italian Western Alps). *Journal of Maps*, 12(5), 1170-1177.

Cady, W. M., Albee, A. L., & Chidester, A. H. (1963). *Bedrock geology and asbestos deposits of the upper Missisquoi Valley and vicinity, Vermont* (No. 1122-B). US Geological Survey.

Campbell, W. J. (1977). Identification of selected silicate minerals and their asbestiform varieties. *National Bureau of Standards, Special Publication*, 506, 201-221.

Cavallo, G. J. (1989). X-ray investigation of "mountain leather". *The Canadian Mineralogist*, 27(2), 237-239.

Chang, P. H., Ern, H. Jr., Thompson, J.B. Jr. (1965). *Bedrock geology of the Woodstock quadrangle, Vermont*, 65 p., 2 plates.

Chatfield, E. J. (2018). Measurement of elongate mineral particles: What we should measure and how do we do it? *Toxicology and applied pharmacology*, 361, 36-46.

Chidester, A. H. (1962). *Petrology and geochemistry of selected talc-bearing ultramafic rocks and adjacent country rocks in north-central Vermont* (No. 345). US Govt. Print. Off.,.

Chidester, A. H., Albee, A. L., & Cady, W. M. (1978). *Petrology, structure, and genesis of the asbestos-bearing ultramafic rocks of the Belvidere Mountain area in Vermont* (No. 1016). US Govt. Print. Off.

Chidester, A. H., Billings, M. P., & Cady, W. M. (1951). *Talc Investigations in Vermont Preliminary Report*. US Geological Survey.

Chidester, A. H., Engel, A. E. J., & Wright, L. A. (1964). *Talc resources of the United States* (No. 1167). US Government Printing Office.

Chidester, A. H., and Shride A. F. (1962). *Asbestos in the United States*, US Geological Survey. 12 pp.

Cogulu, E., & Laurent, R. (1984). Mineralogical and chemical variations in chrysotile veins and peridotite host-rocks from the asbestos belt of southern Quebec. *The Canadian Mineralogist*, 22(1), 173-183.

Coish, R. A., & Gardner, P. (2004). Suprasubduction-zone peridotite in the northern USA Appalachians: evidence from mineral composition. *Mineralogical Magazine*, 68(4), 699-708.

Crane, D. T. (1992). *Polarized Light Microscopy of Asbestos*. Branch of Physical Measurements and Analysis OSHA Salt Lake Technical Center, Salt Lake City, Utah. Revised in 1995.
<https://www.osha.gov/dts/sltc/methods/inorganic/id191/id191.html>

Del Greco, O., & Pelizza, S. (1984). The underground Fontane Talc Mine: main characteristics of the deposit and exploitation methods. *Bollettino dell'Associazione Mineraria Subalpina*, 21, 85-92.

Development Review Board Minutes, Town of Ludlow, Vermont, May 11, 2015.
https://www.ludlow.vt.us/vertical/sites/%7B78E8DA21-0D46-4486-AF59-9D2B5A1048F3%7D/uploads/DRB_Minutes_May_11_2015.pdf

Doll, C. G., Billings, M. P., Cady, W. M., & Thompson, J. B. (Eds.). (1961). *Centennial geologic map of Vermont*. Vermont Geological Survey, Vermont Development Department.

Dorling, M., & Zussman, J. (1987). Characteristics of asbestiform and non-asbestiform calcic amphiboles. *Lithos*, 20(6), 469-489.

Evans, B. W. (2004). The serpentinite multisystem revisited: chrysotile is metastable. *International Geology Review*, 46(6), 479-506.

Evans, B. W., & Ghiorso, M. S. (1995). Thermodynamics and petrology of cummingtonite. *American Mineralogist*, 80(7-8), 649-663.

Ferrini, V., Masi, U., & MONTICELLI, F. (1991). Geochemistry of pyrite from the talc deposit of Val Germanasca (Western Alps, Italy) and genetic implications. *Mineralogica et petrographica acta*, 34, 153-158.

Fiume, M. M., Boyer, I., Bergfeld, W. F., Belsito, D. V., Hill, R. A., Klaassen, C. D., ... & Snyder, P. W. (2015). Safety assessment of talc as used in cosmetics. *International journal of toxicology*, 34(1_suppl), 66S-129S.

Gale, M. H. (1980). *Geology of the Belvidere Mountain Complex, Eden and Lowell, Vermont (No. 80-978)*. US Geological Survey.

Gasco, I., Borghi, A., & Gattiglio, M. (2011). P-T Alpine metamorphic evolution of the Monte Rosa nappe along the Piedmont Zone boundary (Gressoney Valley, NW Italy). *Lithos*, 127(1-2), 336-353.

Gillson, J. L. (1927). Origin of the Vermont talc deposits, with a discussion on the formation of talc in general. *Economic Geology*, 22(3), 246-287.

Greene, R. C. (1995). *Talc resources of the conterminous United States (No. 95-586)*. US Geological Survey.

Gualtieri, A. F., Pollastri, S., Gandolfi, N. B., & Gualtieri, M. L. (2018). In vitro acellular dissolution of mineral fibres: A comparative study. *Scientific reports*, 8(1), 7071.

Gunter, M. E., Belluso, E., & Mottana, A. (2007). Amphiboles: Environmental and health concerns. *Reviews in mineralogy and geochemistry*, 67(1), 453-516.

Guthrie Jr, G. D. (1997). Mineral properties and their contributions to particle toxicity. *Environmental Health Perspectives*, 105(suppl 5), 1003-1011.

Hacker, B. R., & Christie, J. M. (1990). Brittle/ductile and plastic/cataclastic transitions in experimentally deformed and metamorphosed amphibolite. *Geophysical Monograph*, 56, 127-147.

Hardy, J. A., & Aust, A. E. (1995). Iron in asbestos chemistry and carcinogenicity. *Chemical Reviews*, 95(1), 97-118.

Harper, M. (2008). 10th Anniversary critical review: Naturally occurring asbestos. *Journal of Environmental Monitoring*, 10(12), 1394-1408.

Harper, M., Butler, C., Berry, D., & Wroble, J. (2015). Where occupation and environment overlap: US Forest Service worker exposure to Libby Amphibole fibers. *Journal of occupational and environmental hygiene*, 12(5), D47-D53.

Harper, M., Lee, E. G., Slaven, J. E., & Bartley, D. L. (2012). An inter-laboratory study to determine the effectiveness of procedures for discriminating amphibole asbestos fibers from amphibole cleavage fragments in fiber counting by phase-contrast microscopy. *Annals of occupational hygiene*, 56(6), 645-659.

Hess, H. H. (1933). The problem of serpentization and the origin of certain chrysotile asbestos, talc, and soapstone deposits. *Economic Geology*, 28(7), 634-657.

Hodgson, A. A. (1977). Nature and paragenesis of asbestos minerals. *Philosophical Transactions of the Royal Society of London. Series A, Mathematical and Physical Sciences*, 286(1336), 611-624.

Hoffman, M. A., & Walker, D. (1978). Textural and chemical variations of olivine and chrome spinel in the East Dover ultramafic bodies, south-central Vermont. *Geological Society of America Bulletin*, 89(5), 699-710.

Honsberger, I. W., & Laird, J. (2018). Net-Transfer Reactions and Modal Spaces for Ultramafic Slivers, Vermont Appalachians, USA. *The Canadian Mineralogist*, 56(5), 821-846.

Huang, P., & Fuerstenau, D. W. (2001). The effect of the adsorption of lead and cadmium ions on the interfacial behavior of quartz and talc. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 177(2-3), 147-156.

Johannes, W. (1968). Experimental investigation of the reaction forsterite+ H₂O ⇌ serpentine+ brucite. *Contributions to Mineralogy and Petrology*, 19(4), 309-315.

Ilgren, E. B. (2004). The biology of cleavage fragments: a brief synthesis and analysis of current knowledge. *Indoor and Built Environment*, 13(5), 343-356.

Karabinos, P., Macdonald, F. A., & Crowley, J. L. (2017). Bridging the gap between the foreland and hinterland I: Geochronology and plate tectonic geometry of Ordovician magmatism and terrane accretion on the Laurentian margin of New England. *American Journal of Science*, 317(5), 515-554.

Karabinos, P., Mygatt, E. S., Cook, S. M., & Student, M. (2010). Evidence for an orogen-parallel, normal-sense shear zone around the Chester dome, Vermont: a possible template for gneiss dome formation in the New England Appalachians, USA. *From Rodinia to Pangea: The Lithotectonic Record of the Appalachian Region*. Edited by RP Tollo, MJ Bartholomew, JP Hibbard, and PM Karabinos. *Geological Society of America Memoir*, 206, 183-203.

Keith, S. B., & Bain, G. W. (1932). Chrysotile asbestos; I, Chrysotile veins. *Economic Geology*, 27(2), 169-188.

Kelse, J. W., & Thompson, C. S. (1989). The regulatory and mineralogical definitions of asbestos and their impact on amphibole dust analysis. *American industrial hygiene association Journal*, 50(11), 613-622.

Klein, C. (1993). Rocks, minerals and a dusty world. In: Guthrie, GD.; Mossman, B., editors. *Health effects of mineral dusts*. Washington, DC. p. 7-59.

Klein, C., & Hurlbut Jr, C. S. (1993). *Manual of Mineralogy*, 681 p.

Labagnara, D., Patrucco, M., Rossetti, P., & Pellegrino, V. (2013). Predictive assessment of the asbestos content in the Western Italian Alps: an essential tool for an effective approach to risk analysis and management in tunneling operations and muck reuse. *Environmental earth sciences*, 70(2), 857-868.

Lacinska, A. M., Styles, M. T., Bateman, K., Wagner, D., Hall, M. R., Gowing, C., & Brown, P. D. (2016). Acid-dissolution of antigorite, chrysotile and lizardite for ex situ carbon capture and storage by mineralisation. *Chemical Geology*, 437, 153-169.

Lasaga, A. C., & Luttge, A. (2001). Variation of crystal dissolution rate based on a dissolution stepwave model. *Science*, 291(5512), 2400-2404.

Levitan, D. M., Hammarstrom, J. M., Gunter, M. E., Seal, R. R., Chou, I. M., & Piatak, N. M. (2009). Mineralogy of mine waste at the Vermont asbestos group mine, Belvidere Mountain, Vermont. *American Mineralogist*, 94(7), 1063-1066.

Li, Y. Y. (1979). Discussion on the genesis of Longsheng talc mine. *Non-Metallic Mines*, 1, 16-20

Marconi, A., & Verdel, U. (1990). Asbestos content of talcs from Italian mines and fibre concentration in various commercial talcum powders used in Italy. In *Health Related Effects of Phyllosilicates* (pp. 107-115). Springer, Berlin, Heidelberg.

National Research Council. (1984). *Asbestiform fibers: Nonoccupational health risks*. National Academies Press.

Nesbitt, H. W., & Young, G. M. (1984). Prediction of some weathering trends of plutonic and volcanic rocks based on thermodynamic and kinetic considerations. *Geochimica et Cosmochimica Acta*, 48(7), 1523-1534.

Nesse, W. D. (1991). *Introduction to Optical Mineralogy*: Oxford Univ. Press, 335.

Pawley, A. R., & Wood, B. J. (1995). The high-pressure stability of talc and 10 Å phase: potential storage sites for H₂O in subduction zones. *American Mineralogist*, 80(9-10), 998-1003.

Peretti, L. (1966). Geology and genesis of the talc deposits in the Pinerolese. *Bulletin of the Subalpine Mining Association*, 3, 283-304.

Perry, E.L. (1929). *The geology of Bridgewater and Plymouth Townships, Vermont*, in Report of the state geologist on the mineral industries and geology of Vermont, 1927-1928: Burlington, Vt., Free Press Printing Co., p. 1-64.

Phillips, A. H., Hess, H. H. (1936). Metamorphic differentiation at contacts between serpentinite and siliceous country rocks. *Amer. miner.* 21, 333-62.

Plumlee, G. S., Morman, S. A., & Ziegler, T. L. (2006). The toxicological geochemistry of earth materials: an overview of processes and the interdisciplinary methods used to understand them. *Reviews in Mineralogy and Geochemistry*, 64(1), 5-57.

Pollastri, S., D'Acapito, F., Trapananti, A., Colantoni, I., Andreozzi, G. B., & Gualtieri, A. F. (2015). The chemical environment of iron in mineral fibres. A combined X-ray absorption and Mössbauer spectroscopic study. *Journal of hazardous materials*, 298, 282-293.

Pollastri, S., Gigli, L., Ferretti, P., Andreozzi, G. B., Gandolfi, N. B., Pollok, K., & Gualtieri, A. F. (2017). The crystal structure of mineral fibres. 3. Actinolite asbestos. *Periodico di Mineralogia*, 86(2), 89-98.

Rabbitt, J. C. (1948). A new study of the anthophyllite series. *American Mineralogist: Journal of Earth and Planetary Materials*, 33(5-6), 263-323.

Rakovan, J. (2011). Word to the Wise: Serpentine, California's State Rock. *Rocks & Minerals*, 86(1), 63-68.

Ratcliffe, N. M., & Armstrong, T. R. (2001). Bedrock geologic map of the Saxtons River 7.5'× 15' quadrangle. *Windam and Windsor Counties, Vermont: United States Geological Survey Investigations Series Map I-2636, scale, 1(24,000)*.

Ratcliffe, N. M., Stanley, R. S., Gale, M. H., Thompson, P. J., Walsh, G. J., Rankin, D. W., Doolan, B. L., Kim, J., Merhtens, C. J., Aleinikoff, J. N., & McHone, J. G. (2011). *Bedrock geologic map of Vermont* (No. 3184). US Geological Survey.

Robinson, G. R., Van Gosen, B. S., & Foley, N. K. (2006). *Ultramafic-hosted Talc-Magnesite deposits*. US Geological Survey.

Ross, M., Langer, A. M., Nord, G. L., Nolan, R. P., Lee, R. J., Van Orden, D., & Addison, J. (2008). The mineral nature of asbestos. *Regulatory Toxicology and Pharmacology*, 52(1), S26-S30.

Ross, M., & Nolan, R. P. (2003). History of asbestos discovery and use and asbestos-related disease in context with the occurrence of asbestos within ophiolite complexes. *Special Papers-Geological Society of America*, 447-470.

Sandrone, R., Borghi, A., Carosso, G., Morsetti, C., Tagliano, C., & Zucchetti, S. (1990). Geometry of the talc deposit of Fontane, and structural evolution of the area (Dora-Maira Massif, Western Alps). *Bollettino Associazione Mineraria Subalpina*, 27, 45-62.

Sandrone, R., & Zucchetti, S. (1988). Geology of the Italian high-quality cosmetic talc from the Pinerolo district (Western Alps). In *Proceedings of Symposium "Zuffardi'days", Cagliari*.

Sanford, R. F. (1982). Growth of ultramafic reaction zones in greenschist to amphibolite facies metamorphism. *American Journal of Science*, 282(5), 543-616.

Schott, J., Brantley, S., Crerar, D., Guy, C., Borcsik, M., & Willaime, C. (1989). Dissolution kinetics of strained calcite. *Geochimica et Cosmochimica Acta*, 53(2), 373-382.

Siegrist Jr, H. G., & Wylie, A. G. (1980). Characterizing and discriminating the shape of asbestos particles. *Environmental research*, 23(2), 348-361.

Skrotzki, W. (1990). Microstructure in hornblende of a mylonitic amphibolite. Geological Society, London, Special Publications, 54(1), 321-325.

Thompson Jr, J. B. (1970). Recent discussions of pyroxenes and amphiboles-Abstracts. *American Mineralogist*, 55(1-2), 292-297.

Thompson, J. B. (1978). Biopyriboles and polysomatic series. *American Mineralogist*, 63(3-4), 239-249.

Thompson, B. D., Gunter, M. E., & Wilson, M. A. (2011). Amphibole asbestos soil contamination in the USA: A matter of definition. *American Mineralogist*, 96(4), 690-693.

USGS, (1994). The Mineral Industry of Vermont. *Minerals Yearbook*. 239-241
<https://minerals.usgs.gov/minerals/pubs/state/985095.pdf>

Van Gosen et al. (2004). Using the geologic setting of talc deposits as an indicator of amphibole asbestos content. *Environmental Geology*. 45:920-939.

Van Gosen, B. S. (2006). *Reported historic asbestos mines, historic asbestos prospects, and natural asbestos occurrences in the Eastern United States* U.S. Geological Survey Open-File Report (No. 2005–1189) 1 plate. Includes supplementary materials. <https://pubs.usgs.gov/of/2005/1189/>.

Veblen, D. R. (1991). Polysomatism and polysomatic series; a review and applications. *American Mineralogist*, 76(5-6), 801-826.

Veblen, D. R., & Burnham, C. W. (1978). New biopyriboles from Chester, Vermont; I, Descriptive mineralogy. *American Mineralogist*, 63(9-10), 1000-1009.

Veblen, D. R., & Wylie, A. G. (1993). Mineralogy of amphiboles and 1:1 layer silicates. Mineralogical Society of America *Reviews in Mineralogy*, 28, Washington, DC (United States).

Walker, J. S., & Zoltai, T. (1979). A comparison of asbestos fibers with synthetic crystals known as “whiskers”. *Annals of the New York Academy of Sciences*, 330(1), 687-704.

Webb, L. E., Baldwin, S. L., & Fitzgerald, P. G. (2014). The Early-Middle Miocene subduction complex of the Louisiade Archipelago, southern margin of the Woodlark Rift. *Geochemistry, Geophysics, Geosystems*, 15(10), 4024-4046.

Webb, L. E., Johnson, C. L., & Minjin, C. (2010). Late Triassic sinistral shear in the East Gobi fault zone, Mongolia. *Tectonophysics*, 495(3-4), 246-255.

Webb, L. E., Hacker, B. R., Ratschbacher, L., McWilliams, M. O., & Dong, S. (1999). Thermochronologic constraints on deformation and cooling history of high-and ultrahigh-pressure rocks in the Qinling-Dabie orogen, eastern China. *Tectonics*, 18(4), 621-638.

Winter, J.D., 2001, *An Introduction to Igneous and Metamorphic Petrology*. Prentice Hall

Wylie, A. G. (1979). Fiber length and aspect ratio of some selected asbestos samples. *Annals of the New York Academy of Sciences*, 330(1), 605-610.

Wylie, A. G. (2016). Amphibole Dusts: Fibers, Fragments, and Mesothelioma. *The Canadian Mineralogist*, 54(6), 1403-1435.

Wylie, A. G., & Candela, P. A. (2015). Methodologies for determining the sources, characteristics, distribution, and abundance of asbestiform and nonasbestiform amphibole and serpentine in ambient air and water. *Journal of Toxicology and Environmental Health, Part B*, 18(1), 1-42.

Yao, J., Cawood, P. A., Shu, L., Santosh, M., & Li, J. (2016). An early Neoproterozoic accretionary prism ophiolitic mélange from the western Jiangnan Orogenic Belt, South China. *The Journal of Geology*, 124(5), 587-601.

Zhao, Z., Xu, Z., Ma, X., Liang, F., & Guo, P. (2018). Neoproterozoic–Early Paleozoic Tectonic Evolution of the South China Craton: New Insights from the Polyphase Deformation in the Southwestern Jiangnan Orogen. *Acta Geologica Sinica-English Edition*, 92(5), 1700-1727.

Zoltai, T. (1978). History of asbestos-related mineralogical terminology. In *Workshop on Asbestos: Definitions and Measurement Methods. National Bureau of Standards, Special Publication* (Vol. 506, pp. 1-18).

Zoltai, T. (1979). Asbestiform and acicular mineral fragments. *Annals of the New York Academy of Sciences*, 330(1), 621-643.

Zoltai, T. (1981). Amphibole asbestos mineralogy. *Reviews in Mineralogy and Geochemistry*, 9(1), 237-278.

Expert Report of Alan Campion, PhD (November 16, 2018)

Expert Report of Robert B. Cook, PhD (November 16, 2018)

Amended Expert Report of Robert B. Cook, PhD (January 22, 2019)

Robert Cook Deposition (January 30, 2019)

Expert Report of Mark Krekeler, PhD (November 16, 2018)

Addendum to the Expert Report of Mark Krekeler, PhD (January 17, 2019)

Mark Krekeler Deposition (January 25, 2019)

Expert Report of William E. Longo, PhD and Mark W. Rigler, PhD (November 14, 2018)

Supplementary Expert Report of William E. Longo, PhD & Mark W. Rigler, PhD (January 16, 2019)

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JNJTALC000347819

<http://www.science.smith.edu/geosciences/petrology/petrography/hornblende/P1010004.jpg>

<https://dec.vermont.gov/geological-survey/publication-gis/VTrock>

https://usgsprobe.cr.usgs.gov/images/asbestos_2.jpg

<https://usgsprobe.cr.usgs.gov/images/hexagonite.jpg>

EXHIBIT A

Dr. Laura E. Webb

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EDUCATION

PhD in Geological and Environmental Sciences, Stanford University, Stanford, California, 1999.
Doctoral Dissertation: "Exhumation of high and ultrahigh-pressure rocks in the Qinling–Dabie Orogen, eastern China and the Yagan–Onch Hayrhan metamorphic core complex, southern Mongolia." M.O. McWilliams, advisor. W.G. Ernst, S.A. Graham, and B.R. Hacker (UCSB), committee members.
BS in Geology, University of California, Los Angeles, *cum laude*, 1994.

APPOINTMENTS

Associate Professor, Department of Geology, University of Vermont, Burlington, Vermont, Fall 2014–present.
Assistant Professor, Department of Geology, University of Vermont, Burlington, Vermont, 2008–2014.
Graduate Faculty, University of Vermont, Burlington, Vermont, 2009–present.

PREVIOUS RESEARCH AND WORK EXPERIENCE

Research Assistant Professor, Department of Earth Sciences, Syracuse University, Syracuse, NY, 2004–2012.
Syracuse University Noble Gas Isotopic Research Laboratory Manager, Department of Earth Sciences, Syracuse University, Syracuse, NY, 2000–2008.
⁴⁰Ar/³⁹Ar Laboratory Manager, University of Geneva, Switzerland, 1999–2000.
Staff Geologist, American Geotechnical, Anaheim, California, 1994.

AWARDED GRANTS AND CONTRACTS

2018–2021, DMR 1828371, National Science Foundation Major Research Instrumentation, \$480,000: "MRI: Acquisition of a Variable-Pressure, Field-Emission Scanning Electron Microscope for Materials Research and Education" **Co-PI**. Collaborative with M. White (PI), C. Landry, R. Headrick, and F. Sansoz.
2016–2017, University of Vermont, College of Arts and Sciences, Seed Grant, \$9843, Subduction–Exhumation History of the Tillotson Peak Complex, Vermont." **PI**.
2010–2015, EAR 1028991, NSF Instrumentation and Facilities, \$507,978: "Acquisition of a noble gas mass spectrometer and development of a multi-user facility for ⁴⁰Ar/³⁹Ar geochronology at the University of Vermont." **PI**.
2010–2014, EAR 0948529, NSF Petrology and Geochemistry and co-sponsored by Tectonics, \$194,493: "Collaborative Research: Constraining P-T-t-D paths of metamorphic tectonites

with the TitaniQ thermobarometer.” **PI.** Collaborative research with F. Spear and J. Thomas (Rensselaer Polytechnic Institute).

2007–2014, EAR 0709054, NSF Continental Dynamics, \$1,282,742: “Collaborative Research: How Is Rifting Exhuming the Youngest HP/UHP Rocks on Earth?” **Co-PI.** Collaborative with S. Baldwin (PI) and P. Fitzgerald (Syracuse University). Collaborative research with G. Abers, T. Plank, W.R. Buck & J. Gaherty (Columbia University), B. Hacker (UCSB), and P. Mann & B. Horton (UT Austin).

2009–2013, DUE 0941255, NSF Course Curriculum and Laboratory Improvement Program, \$103,410: “Collaborative Research: Field-based Projects Exploring Geophysical Methods, with Applications to the State of Vermont.” **PI.** Keith Klepeis, Co-PI. Collaborative research with D. Westerman and G. Springston (Norwich University; and the Vermont Geological Survey).

2006–2011, EAR 0537165 & EAR-0929902, NSF Tectonics, \$267,223: “Collaborative Research: Strike-Slip History of the East Gobi Fault Zone, Mongolia: Modes of Intraplate Deformation, Sedimentary Basin Evolution, and Regional Fault Linkages”. **PI.** Collaborative research with C. Johnson (University of Utah).

2004–2007, EAR 0345822, NSF Instrumentation and Facilities, \$77,340: “Acquisition of an excimer laser system for Syracuse University Noble Gas Isotope Research Laboratory (SUNGIRL)”. **Co-PI** with S. Baldwin.

TECHNICAL EXPERTISE

Nu Noblesse, MAP 216 and Micromass 5400 noble gas mass spectrometers for $^{40}\text{Ar}/^{39}\text{Ar}$ thermochronology.

Balzers Prisma QME 200 quadrupole mass spectrometer for (U-Th)/He thermochronology.

Design, construction, and maintenance of ultra-high vacuum extraction lines.

Management of radioactive materials and isotopic inventories.

Other analytical experience: electron microprobe analyses, secondary ionization mass spectrometry, laser ablation inductively couple mass spectrometry, cathodoluminescence imaging.

CONSULTING EXPERIENCE

2017–present: Formation of high-purity talc deposits mined for Johnson & Johnson talcum powders and their relationships, or lack thereof, to asbestos. Retained by law firms representing Johnson & Johnson in talc-related litigation.

COURSES REGULARLY TAUGHT AT UVM

*Denotes new courses at UVM developed by Webb

GEOL 161 Field Methods in Geophysics*. As of fall 2015, this is a recognized service-learning course and fulfills the University-wide sustainability general education requirement.

GEOL 231 Petrology

GEOL 240 Tectonics

GEOL 263 Geochronology*

GEOL 266 Microstructures*

GEOL 302 Introduction to Graduate Studies

INTERNATIONAL GEOLOGIC FIELD CAMPAIGNS

2011: Coastal batholith, Central Chile.
2010: Islands of the Woodlark Rise, southeastern Papua New Guinea.
2009: East Gobi Fault Zone, southern Mongolia.
2009: Louisiade Archipelago, southeastern Papua New Guinea.
2008: D'Entrecasteaux Islands, southeastern Papua New Guinea.
2004, 2006, 2007: East Gobi Fault Zone, southern Mongolia.
2002: Sulu ultrahigh-pressure terrane, Shandong peninsula, China.
1997, 1998: Southern Mongolia.
1994, 1995, 1996: Qinling–Dabie orogen, China.

HONORS, AWARDS AND PROFESSIONAL AFFILIATIONS

Member of: Geological Society of America, Mineralogical Society of America, American Geophysical Union, Vermont Geological Society, and American Association for the Advancement of Science.

Nominated for the 2018 Kroepsch-Maurice Excellence in Teaching Award at the associate professor level, University of Vermont.

2018 Awardee of “Outstanding New Service-Learning Faculty”, Community-University Partnerships & Service-Learning (CUPS). Nominated for GEOL161 Field Methods in Geophysics course.

UVM Faculty Fellow for Service Learning, AY2014–2015. Participant in service learning workshops and working towards UVM designation of GEOL161 Field Methods in Geophysics as a service-learning course.

Featured in an article on NSF-funded research on titanium-in-quartz thermobarometry in *International Innovation*. “Under Pressure”, *International Innovation*, North America, August 2012, Issue 3, pp. 120–122.

UVM Sustainability Faculty Fellow, 2012. Participant in program designed to foster integration of interdisciplinary approaches to sustainability into the UVM curriculum; enhance the understanding of sustainability concepts among those not trained in environmental fields; and to explore curriculum design strategies that will engage students in thinking about sustainability from a multidisciplinary perspective.

Nominated for the 2011 Kroepsch-Maurice Excellence in Teaching Award at the assistant professor level, University of Vermont.

PROFESSIONAL DEVELOPMENT AND WORKSHOPS

Participant in Scholarship of Teaching and Learning initiative (AY2017–2018). Development of Action Research project related to revision of GEOL 240 Tectonics course employing scaffolding approaches to facilitate student achievement of writing and information learning outcomes for Geology.

Designing for Learning Spring 2017 Cohort, University of Vermont. Participated in semester-long program for faculty to help identify and reduce student barriers to learning.

Co-convenor of EarthScope synthesis workshop, *Synthesizing EarthScope Results: Develop a New Model for the 4-D Evolution of North America*, James Madison University, Harrisonburg, Virginia, November 2016.

Participant and breakout group synthesizer in the NSF-sponsored *Future of Tectonics Workshop*, University of Wisconsin, Madison, Wisconsin, May 2016.

Campuses for Environmental Stewardship, Faculty Development Institute and Training. November 5-6, 2015, Portland, Maine. Part of UVM team for development of sustainability service learning courses (participant in UVM subgrant from Maine Campus Compact project funded by the Davis Educational Foundation).

Participant in UVM Honors College Faculty Seminar, August 11–13, 2014: *‘Big Data’: Engaging and Critiquing the Production of Knowledge in the Digital Age*.

Outcomes of the Future of Geoscience Undergraduate Education Summit webinar participant, March, 2013.

EarthCube domain end-user workshop: Bringing Geochronology into the EarthCube framework. October, 2013, University of Wisconsin – Madison. Invited participant. The overall goal of the workshop is to: 1) identify the scientific challenges and opportunities facing the geochronology domain for next 5-15 years; 2) specify the data and cyber-infrastructure obstacles to meeting those challenges; 3) compile a list of known community data and modeling resources; 4) describe the data and cyber-capabilities required to meet challenges, by matching obstacles (2) with resources (3) and identifying/imagining unmet needs that may develop; and 5) develop ideas for at least two “proof-of-concept” projects or test cases for scientifically transformative activities that would become feasible if EarthCube is successful.

Systems, Society, Sustainability and the Geosciences Workshop. July 2012, Carleton College. This workshop is part of the InTeGrate project, a five-year, NSF-funded STEP Center grant geared towards increasing undergraduate geoscience literacy and “increase the number of majors in the geosciences and associated fields who are able to work with other scientists, social scientists, business people, and policy makers to develop viable solutions to current and future environmental and resource challenges.”

Early Career Geoscience Faculty Workshop: Teaching, Research, and Managing Your Career. National Science Foundation On the Cutting Edge workshop series, College of William and Mary, 2008.

Participant in the NSF-funded *U.S.–Russia Workshop on the Plate Tectonic Evolution of Northeast Russia*. Stanford University, 2004.

Fourth International Symposium on Andean Geodynamics. University of Göttingen, Germany, 1999.

Exhumation Processes: Normal Faulting, Ductile Flow, and Erosion. Penrose Conference, Greece, 1996.

Ultrahigh-Pressure Metamorphism and Tectonics workshops. Stanford University, 1994 and 1999.

PROFESSIONAL SERVICE AND EDUCATIONAL OUTREACH

National Science Foundation EarthScope Steering Committee, member. Fall 2015–present.

Member of the UVM General Education Sustainability Assessment Committee, Spring 2016–Present. Co-Chair of committee during AY2017–2018 and AY2018–2019.

Member of the Standard Four: Academic Program Committee for UVM’s 10-year reaccreditation review from the New England Association of Schools and Colleges (NEASC) in 2019, AY2017–2018.

Session organizer and convener, “Orogenic Sutures—Recognition, Characterization, and Tectonic Implications”. Geological Society of America Northeastern Section Annual Meeting, Burlington, Vermont, March 2018.

Appointee to three-year term on the College of Arts and Sciences Deans Academic Planning and Budget Committee, Fall 2014–Spring 2017.

Co-convener of NSF EarthScope synthesis workshop: Synthesizing EarthScope Results to Develop a New Community Model for the 4-D Evolution of North America. November 18–20, 2016, at James Madison University, Harrisonburg, Virginia.

Department of Geology liaison for the Writing and Information Literacy in the Disciplines (WILD) General Education initiative, Spring 2014–Fall 2016.

Rock Point Funding and Staffing Committee, Land Use Implementation Plan, Spring 2015–2016.

Session organizer and convener, “Bridging Two Continents: Comparative Studies of Accretionary Orogenesis in the Central Asian Orogenic Belt, North American Cordillera, and Other Orogenic Belts”. Joint meeting of the Geological Society of America (GSA) and the Geological Society of China (GSC), 2015 GSA Annual Meeting, Baltimore, Maryland, November 2015.

NSF EarthScope 2015 National Meeting organizing committee member. Stowe, Vermont, June 2015.

NSF EarthScope 2015 National Meeting organizer and co-leader of conference field trip. Stowe, Vermont, June, 2015.

Regular reviewer of NSF proposals (2–5 per year typical; Tectonics, Instrumentation and Facilities, Integrated Earth Systems, Petrology and Geochemistry, EarthScope, and CAREER programs) and journal manuscripts (5–10 per year typical. Journals include: *Geology*, *Tectonics*, *Journal of Metamorphic Geology*, *Terra Nova*, *GSA Bulletin*, *Journal of Structural Geology*, *Journal of Geology*, *Lithos*, *Journal of Geophysical Research – Solid Earth*, *Tectonophysics*, *Geoscience Frontiers*, *Journal of Asian Earth Sciences*, *Earth Science Reviews*, and *European Journal of Mineralogy*).

Department of Geology Graduate Student Coordinator, 2010–2013.

Organizer of Geology Seminar Series, Department of Geology, University of Vermont, 2009–2013.

Session organizer and convener, “Innovations in Geochronology: Present Developments and a Vision for 2020.” 2013 Goldschmidt conference, Florence, Italy.

Member of the sustainability general education requirement committee charged with developing a suite of learning outcomes and methods of assessment for a university-wide sustainability general education requirement. 2013–2014.

UVM College of Arts and Sciences Academic Standing Committee, Fall 2010–Spring 2013.

Search committee member for Department of Geology tenure-track position in geochemistry, Spring 2013.

Earth Sciences proposal review panel member, National Science Foundation, Tectonics Program, served two single-term appointments in 2011 and 2012.

UVM College of Arts and Sciences summer orientation registration advising, 2009–2013.

Session organizer and convener, “The Wilson Cycle Revisited: From Microplates and Mobile Terranes to Supercontinent Dispersals.” 2010 American Geophysical Union Fall Meeting.

Search Committee member for Department of Geology Chairperson, Spring 2010.

Faculty Senator, University of Vermont, 2009–2010.

Advisor to Geology Club and the Eta Kappa Chapter of the Sigma Gamma Epsilon National Honor Society for Earth Sciences, University of Vermont, 2009–2010.

Session organizer and convener, "Intraplate Deformation and Sedimentary Basins: A Record of Plate Margin Processes?" 2009 American Geophysical Union Fall Meeting.

UVM coordinator for the Vermont Geological Society Spring Meeting, April 2009.

Organizer of Geoscience Career Workshop, Department of Geology, University of Vermont, April 2009.

Session organizer and convener, "Microplate Geodynamics." 2008 American Geophysical Union Fall Meeting.

INVITED LECTURES

November 2018, Johns Hopkins University, "Insights into polyphase deformation and fault reactivation from $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology."

April 2018, University of Miami Ohio, "Punctuated melt-enhanced deformation and tectonic reactivation above a long-lived subduction zone, Coastal Andes, Central Chile."

October 2016, University of Iowa, "Structural and isotopic constraints on the development of a major Phanerozoic intraplate fault zone".

February 2016, University of Wisconsin, Madison, "Slippery when wet: Confessions of an intraplate fault zone."

March 2015, University of Massachusetts, Amherst, "How to look older than your age: Phanerozoic life in the fastlane of the East Gobi Fault Zone."

October 2014, invited lecture on $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology, Geological Society of America short course "EarthScope: Geochronology and the Earth Sciences", 2014 GSA Annual Meeting, Vancouver, Canada.

March 2012, McGill University GEOTOP Seminar, "The Epic Saga of Tavan Har: Phanerozoic Continental Growth, Collisional Orogenesis, and Intraplate Deformation in Southeastern Mongolia."

March 2012, University of New Hampshire Randolph W. Chapman Colloquium, "The Epic Saga of Tavan Har: Phanerozoic Continental Growth, Collisional Orogenesis, and Intraplate Deformation in Southeastern Mongolia."

September 2009, Department of Geology, Colby College, "P-T-t-D Paths of Metamorphic Tectonites and Making the Leap from Micron to Plate Scale."

October 2008, Department of Geology, Middlebury College, "Can subduction be undone? Examining the role of microplate rotation in the exhumation of high and ultrahigh-pressure rocks in Papua New Guinea."

April 2008, Syracuse University College of Arts and Sciences Frontiers of Science Lecture Series, "How do plate boundaries evolve on Earth?"

February 2008, Department of Geology, University of Vermont, "What's under the rug? Unraveling the tectonic history of southeastern Mongolia."

November 2006, Department of Geology & Geography, West Virginia University, "Unraveling complex intraplate deformation in southeastern Mongolia."

PUBLICATIONS IN PEER-REVIEWED JOURNALS

Student authors indicated in italics

- Klepeis, K.A., **Webb, L.E.**, *Blatchford, H.*, Schwartz, J., Jongens, R., Turnbull, R., and Stowell, H., *in review*, Crust-mantle interactions above the Puysegur subduction zone in Fiordland, New Zealand. *GSA Today*.
- Brombin, V.*, Bonadiman, C., Jourdan, F., Roghi, G., Coltari, M., **Webb, L.E.**, Callegaro, S., Bellieni, G., De Vecchi, G., Sedea, R., Marzoli, A., *in revision*, Intraplate magmatism at a convergent plate boundary, the case of the Cenozoic northern Adria magmatism. *Earth-Science Reviews*.
- Webb, L.E.**, and Klepeis, K.A., *in press*, $^{40}\text{Ar}/^{39}\text{Ar}$ constraints on the Tectonic evolution of the Late Paleozoic and Early Mesozoic accretionary complex of coastal Central Chile. Book chapter *in* Horton, B., and Folguera, A. eds. *Andean Tectonics*; Elsevier.
- Cordova, J.L.*, Mulcahy, S.R., Schermer, E.R., and **Webb, L.E.**, 2018, Subduction initiation and early evolution of the Easton Metamorphic Suite, Northwest Cascades, Washington. *Lithosphere*, v. 11, no. 1, p. 44-58, doi.org/10.1130/L1009.1.
- Heumann, M.J.*, Johnson, C.L., **Webb, L.E.**, 2017, Plate interior polyphase fault systems and sedimentary basin evolution: Case study of the East Gobi Basin and East Gobi Fault Zone, southeastern Mongolia, *Journal of Asian Earth Sciences*, v. 151, p. 343–358, doi: 10.1016/j.jseaes.2017.05.017.
- Webber, J.R.*, Klepeis, K.A., **Webb, L.E.**, Cembrano, J., Morata, D., Mora-Klepeis, G., and Arancibia, G., 2015, Deformation and magma transport in a crystallizing plutonic complex, Coastal Batholith, central Chile, *Geosphere*, v. 11, no. 5., p. 1401-1426.
- Webb, L.E.**, Baldwin, S.L. and Fitzgerald, P.G., 2014, The Early–Middle Miocene subduction complex of the Louisiade Archipelago, southern margin of the Woodlark Rift. *Geophysics, Geochemistry, Geosystems*, doi: 10.1002/2014GC005500.
- Heumann, M.J.*, Johnson, C.L., **Webb, L.E.**, *Taylor, J.P.*, Jalbaa, U., and Minjin, C., 2014, Total and incremental left-lateral displacement across the East Gobi Fault Zone, southern Mongolia: implications for timing and modes of polyphase intracontinental deformation, *Earth and Planetary Science Letters*, v. 392, p. 1-15, doi: 10.1016/j.epsl.2014.01.016.
- Ashley, K.T.*, **Webb, L.E.**, Spear, F.S., and Thomas, J.B., 2013, P-T-D histories from quartz: A case study of the application of the TitaniQ thermobarometer to progressive fabric development in metapelites, *Geochemistry, Geophysics, Geosystems*, v. 14, doi: 10.1002/ggge.20237.
- Taylor, J.*, **Webb, L.**, Johnson, C., and *Heumann, M.*, 2013, The lost South Gobi Microcontinent: protolith studies of metamorphic tectonites and implications for the evolution of continental crust in southeastern Mongolia, *Geosciences*, special issue: Continental Accretion and Evolution, doi:10.3390/geosciences3030543.
- Leech, M.L., and **Webb, L.E.**, 2013, Is the HP-UHP Hong'an-Dabie-Sulu orogen a piercing point for offset on the Tan-Lu fault? *Journal of Asian Earth Sciences*, v. 62, p. 112–129, DOI: 10.1016/j.jseaes.2012.08.005.
- Spear, F., *Ashley, K.T.*, **Webb, L.E.**, and Thomas, J., 2012, Ti diffusion in quartz inclusions: implications for metamorphic time scales, *Contributions to Mineralogy and Petrology*, DOI: 10.1007/s00410-012-0783-z.

- Baldwin, S.L., Fitzgerald, P.G., and **Webb, L.E.**, 2012, Tectonics of the New Guinea region, Annual Review of Earth and Planetary Sciences, v. 40, p. 495-520, doi: 10.1146/annurev-earth-040809-15254, **INVITED**.
- Heumann, M.J., Johnson, C.L., **Webb, L.E.**, Taylor, J.P., Jalbaa, U., and Minjin, C., 2012, Paleogeographic reconstruction of a late Paleozoic arc collision zone, southern Mongolia, Geological Society of America Bulletin, doi:10.1130/B30510.1.
- Webb, L.E.**, Johnson, C.L., and Minjin, C., 2010, Late Triassic sinistral shear in the East Gobi Fault Zone, Mongolia, Tectonophysics, v. 495, p. 246-255, doi: 10.1016/j.tecto.2010.09.033.
- Webb, L.E.**, Baldwin, S.L., Little, T.A., and Fitzgerald, P.G., 2008, Can microplate rotation drive subduction inversion? Geology, v. 36, p. 823–826.
- Baldwin, S.L., **Webb, L.E.**, and Monteleone, B.D., 2008, Late Miocene coesite-eclogite exhumed in the Woodlark Rift, Geology, v. 36, p. 735–738.
- Monteleone, B.D., Baldwin, S.L., **Webb, L.E.**, Fitzgerald, P.G., Grove, M., and Schmidt, A.K., 2007, Late Miocene–Pliocene eclogite-facies metamorphism, D'Entrecasteaux Islands, SE Papua New Guinea, Journal of Metamorphic Geology, v. 25, p. 245–265.
- Webb, L.E.**, and Johnson, C.L., 2006, Tertiary strike-slip faulting in southeastern Mongolia and implications for Asian tectonics, Earth and Planetary Science Letters, v. 241, p. 323–335.
- Webb, L.E.**, Leech, M.L., and Yang, T., 2006, $^{40}\text{Ar}/^{39}\text{Ar}$ thermochronology of the Sulu terrane: Late Triassic exhumation of high and ultrahigh-pressure rocks and implications for Mesozoic tectonics in East Asia, in Geological Society of America Special Paper *Ultrahigh-Pressure Metamorphism: Deep Continental Subduction*, edited by B.R. Hacker, B. McClelland, and J.G. Liou, p. 77–92.
- Leech, M.L., **Webb, L.E.**, and Yang, T., 2006, Diachronous histories for the Dabie-Sulu orogen from high-temperature geochronology, in Geological Society of America Special Paper *Ultrahigh-Pressure Metamorphism: Deep Continental Subduction*, edited by B.R. Hacker, B. McClelland, and J.G. Liou, p. 1–22.
- Lewis, A.R., Marchant, D.R., Baldwin, S.L., and **Webb, L.E.**, 2006, The age and origin of the Labyrinth, western Dry Valleys, Antarctica: evidence for extensive middle Miocene subglacial floods and freshwater discharge to the Southern Ocean, Geology, v. 34, p. 513–516.
- Fitzgerald, P., Baldwin, S., **Webb, L.E.**, and O'Sullivan, P., 2006, Interpretation of (U-Th)/He single grain ages from slowly cooled crustal terranes: A case study from the Transantarctic Mountains of southern Victoria Land, Chemical Geology, v. 225, p. 91–120.
- Baldwin, S.L., Monteleone, B., **Webb, L.E.**, Fitzgerald, P.G., Grove, M and Hill, E.J., 2004, Pliocene eclogite exhumation at plate tectonic rates in eastern Papua New Guinea, Nature, v. 431, p. 263–267.
- Ratschbacher, L., Hacker, B.R., Calvert, A., **Webb, L.E.**, Grimmer, J.C., McWilliams, M., Ireland, T.R., Dong, S. and Hu, J., 2003, Tectonics of the Qinling (central China): Tectonostratigraphy, geochronology, and deformation kinematics, Tectonophysics, v. 336, p. 1–53.
- Johnson, C.L., **Webb, L.E.**, Graham, S.A., Hendrix, M., and Badarch, G., 2001, Sedimentary and structural records of late Mesozoic high-strain extension and strain partitioning, East Gobi Basin, southern Mongolia, Memoir - Geological Society of America, v. 194, p. 231–246.
- Webb, L.E.**, Ratschbacher, L., Hacker, B.R. and Dong, S., 2001, Kinematics of exhumation of high- and ultrahigh-pressure rocks in the Hong'an and Tongbai Shan of the Qinling–Dabie collisional orogen, eastern China, Memoir - Geological Society of America, v. 194, p. 413–434.

- Graham, S.A., Hendrix, M.H., Johnson, C.L., D. Badamgarav, G. Badarch, Amory, J., Porter, M., R. Barsbold, **Webb, L.E.**, Hacker, B., 2001, Sedimentary record and tectonic implications of Mesozoic rifting in southeast Mongolia, GSA Bulletin, v. 113, p. 1560–1579.
- Hacker, B.R., Ratschbacher, L., **Webb, L.E.**, McWilliams, M., Calvert, A., Dong, S., Wenk, H.-R., and Chateigner, D., 2000. Exhumation of ultrahigh-pressure rocks in the Dabie-Hong'an area: Late Triassic-Early Jurassic tectonic unroofing, Journal of Geophysical Research, v. 105, p. 13,339–13,364.
- Ratschbacher, L., Hacker, B.R., **Webb, L.E.**, Calvert, A., Ireland, T.R., McWilliams, M.O., Dong, S., Chateigner, D., and Wenk, H.-R., 2000. Exhumation of the ultrahigh-pressure continental crust in east-central China: Cretaceous and Cenozoic unroofing and the Tan-Lu Fault, Journal of Geophysical Research, v. 105, 13303–13338.
- Lamb, M.A., Hanson, A.D., Graham, S.A., Badarch, G., and **Webb, L.E.**, 1999, Left-lateral sense offset of Upper Proterozoic and Paleozoic features on the Gobi Onon, Tost, and Zuunbayan faults in southern Mongolia and implications for other central Asian faults, Earth and Planetary Research Letters, v. 173, p. 183–194
- Webb, L.E.**, Hacker, B.R., Ratschbacher, L., Michael O. McWilliams, and Dong S., 1999. Thermochronologic constraints on deformation and cooling history of high and ultrahigh-pressure rocks in the Qinling–Dabie orogen, Tectonics, v. 18, p. 621–638.
- Webb, L.E.**, Graham, S.A., Johnson, C.L., Badarch, G., Hendrix, M., 1999. Occurrence, age, and implications of the Yagan–Onch Hayrhan metamorphic core complex, southern Mongolia, Geology, v. 27, p. 143–146.
- Hacker, B.R., Ratschbacher, L., **Webb, L.E.**, Ireland, T., Walker, D., and Dong S., 1998. U/Pb Zircon ages constrain the architecture of the ultrahigh-pressure Qinling–Dabie orogen, China, Earth and Planetary Science Letters, v.161, p. 215–230.
- Hacker, B.R., Ratschbacher, L., **Webb, L.E.**, and Dong S., 1995. What brought them up? Exhumation of the Dabie Shan ultrahigh-pressure rocks, Geology, v. 23, p. 743–746.

WHITE PAPERS

- Crespi, J., Klepeis, K., Williams, M., Thomas, W., **Webb, L.**, Gale, M., Kim, J., and Becker, L., 2011, EarthScope in the New England Appalachians: Structural inheritance and the long-term strength of continental lithosphere. National Science Foundation Joint EarthScope-GeoPRISMS Science Workshop for Eastern North America.
- Baldwin, S., Fitzgerald, P., Curewitz, D., Mann, P., Hacker, B., **Webb, L.**, Abers, G., Little, T., Wallace, L., Devey, C., Hoernle, K., Speckbacher, R., and Behrmann, J., 2010, Rift Initiation and Evolution within an Active Plate Boundary Zone: The Woodlark Rift of Papua New Guinea. National Science Foundation GeoPRISMS Rift Initiation and Evolution (RIE) initiative.

PUBLISHED (REFERREED) ABSTRACTS OF CONFERENCE PRESENTATIONS

Student authors indicated in italics

- Webb, L.E., 2019. Revelations from EarthScope on the Dynamic History of North America. Association for the Advancement of Science, Annual Meeting, Washington D.C. **INVITED.**
- McGrew, A.J., *Rodgers, A.*, Metcalf, J.R., Mesiner, C.B., and **Webb, L.E.**, 2018. Tracking the escalator ride from mid-crustal depths to the surface: New constraints on the pace and episodicity of late Eocene to Miocene exhumation from the southern east Humboldt Range

- metamorphic core complex, Elko County, Nevada. Geological Society of America Abstracts with Programs. Vol. 50, No. 6. doi: 10.1130/abs/2018AM-318419.
- Baldwin, S.L., Fitzgerald, P.G., **Webb, L.E.**, Malusa, M.G., and Moucha, R., 2018. How to make and exhume (U)HP terranes: insights from southeastern Papua New Guinea (EOS, Transactions, American Geophysical Union, Fall Meeting). **INVITED.**
- Gonzalez, J.*, Baldwin, S.L., Thomas, J.B., Fitzgerald, P.G., **Webb, L.E.**, and Kim, J.J., 2018. Peak pressure-temperature-time estimates for Taconic orogen high-pressure rocks, Tillotson Peak Complex, Vermont. (EOS, Transactions, American Geophysical Union, Fall Meeting).
- Tam, E.*, Webb, L.E., and *Aiken, C.*, 2018. Geochronologic Constraints on the Timing of Deformation in the Footwall of the Prospect Rock Fault in North-Central Vermont. Geological Society of America Abstracts with Programs. Vol. 50, No. 2, doi: 10.1130/abs/2018NE-310928.
- Caswell, B.*, Gilotti, J.A., Webb, L.E., Jones, D.A., McClelland, W.C., 2018. $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronology of Biotite from Ductile Shear Zones of the Ellesmere-Devon Crystalline Terrane, Nunavut, Canadian Arctic. Geological Society of America Abstracts with Programs. Vol. 50, No. 2, doi: 10.1130/abs/2018NE-310455
- Dundas, E.*, Ehlers, A., Lee, J., *Titsworth, K.*, Weiss, H., and **Webb, L.E.**, 2018. Use of Ground-Penetrating Radar and Electromagnetic Induction Profiling to Image a Buried Revolutionary War Trench at Chimney Point, Addison County, Vermont. Geological Society of America Abstracts with Programs. Vol. 50, No. 2, doi: 10.1130/abs/2018NE-311041.
- Aiken, C.L.*, and **Webb, L.E.**, 2018. Geochronologic Constraints on the Timing of Metamorphism and Exhumation of the Tillotson Peak Complex in Northern Vermont. Geological Society of America Abstracts with Programs. Vol. 50, No. 2, doi: 10.1130/abs/2018NE-310829.
- Webb, L.E.**, Klepeis, K.A., and Kim, J.J., 2018. New Insights on Acadian Deformation and Reactivation in Northern Vermont from Integrated Structural and Geochronological Studies. Geological Society of America Abstracts with Programs. Vol. 50, No. 2, doi: 10.1130/abs/2018NE-311032.
- Klepeis, K., **Webb, L.E.**, *Merson, M.Q.*, and Kim, J.J., 2018. Unraveling Fault Reactivations and Their Tectonic Significance Using Integrated Structural Data and $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronology, Examples from N. Vermont and S.W. New Zealand. Geological Society of America Abstracts with Programs. Vol. 50, No. 2, doi: 10.1130/abs/2018NE-311301.
- Maguire IV, H.C.*, Merhtens, C., Chiarenzelli, J., and Webb, L.E., 2018. Detrital Zircon Ages for the Cambrian Monkton and Danby Formations, Champlain Valley, Vermont. Geological Society of America Abstracts with Programs. Vol. 50, No. 2, doi: 10.1130/abs/2018NE-311008.
- Gonzalez, J.P.*, Baldwin, S., Kim, J.J., and **Webb, L.E.**, 2018. A Comparison of Pressure-Temperature-Time Histories across the Burgess Branch Fault Zone, Northern Vermont. Geological Society of America Abstracts with Programs. Vol. 50, No. 2, doi: 10.1130/abs/2018NE-310874.
- Brombin, V.*, Marzoli, A., Roghi, G., Fred, J., Coltorti, M., Bonadiman, C., **Webb, L.E.**, Sara, C., Giuliano, B., De Vecchi, G. and Roberto, S., 2018. The temporal evolution of the Cenozoic Southalpine magmatic activity in North-East Italy: evidence from $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology. In European Geosciences Union (pp. 1-1). European Geosciences Union.

- Tam, E., Webb, L.E., and Aiken, C.L., 2017, Role of the Prospect Rock Fault in the Exhumation of High Pressure Rocks in North-Central Vermont. (EOS, Transactions, American Geophysical Union).*
- Klepeis, K., **Webb, L.E.**, Blatchford, H.J., Schwartz, J.J., Turnbull, R., and Jongens, R., 2017. Unraveling a history of repeated fault reactivations and differential uplift above a young subduction zone in SW New Zealand, Geological Society of America Abstracts with Programs. Vol. 49, No. 6, doi: 10.1130/abs/2017AM-306155.
- Webb, L.E.**, 2017. Strange results or: How I learned to stop worrying and love complicated $^{40}\text{Ar}/^{39}\text{Ar}$ apparent age spectra. Geological Society of America Abstracts with Programs. Vol. 49, No. 6, doi: 10.1130/abs/2017AM-306106.
- Cordova, J.L., Schermer, E., Mulcahy, S.R., and Webb, L.E., 2017. Initiation and early evolution of a subduction zone: T-t-D history of the Easton metamorphic suite, northwest Washington State, Geological Society of America Abstracts with Programs. Vol. 49, No. 6, doi: 10.1130/abs/2017AM-303853.*
- Fitzgerald, P.G., Baldwin, S.L., Bermúdez, M.B., **Webb, L.E.**, Little, T.A., Miller, S.R., Malusà, M.G., Seward, D., 2017. Rift-triggered exhumation of eclogite-bearing gneiss domes in eastern Papua New Guinea: Geologic and thermochronologic constraints. 12th International Eclogite Conference, Åre, Sweden, August 2017.
- Aiken, C., and Webb, L.E., 2017. Exhumation of the Tillotson Peak complex in northern Vermont. Northeastern North-Central Joint Section Meeting of the Geological Society of America. Pittsburgh, Pennsylvania.*
- Brombin, V., Webb, L., Bonadiman, C., Marzoli, A., and Coltorti, M., 2017. A geochronological study of mafic and acidic lavas from Veneto Volcanic province (North-East Italy), EGU General Assembly 2017, Vienna, Austria. Geophysical Research Abstracts, Vol. 19, EGU2017-6410, 2017.*
- Ebinger, C., Humphreys, E., Williams, M., van der Lee, S., Levin, V., **Webb, L.**, and Becker, T., 2017. Dynamics and the Wilson Cycle: An EarthScope vision. EGU General Assembly 2017, Vienna, Austria. Geophysical Research Abstracts, Vol. 19, EGU2017-5829.
- Webb, L.E.**, Klepeis, K.A., Kim, J., and *Sullivan, P.*, 2017, Reactivation of Taconic Thrust Faults in the Late Acadian Orogenic Front. 2017 EarthScope National Meeting. Anchorage, Alaska.
- Mehrtens, C., **Webb, L.E.**, Harrington, S., Desanto, D., and Berman, E., 2016. Writing and Information Literacy in The Geosciences: A Pilot Project to Improve Student Understanding and Communication, Geological Society of America Abstracts with Programs. Vol. 48, No. 7, doi: 10.1130/abs/2016AM-277481.
- Tsai, C.-H., Liu, C., **Webb, L.**, and Keyser, W., 2016, New P-T and Geochronological Constraints on High-Pressure Garnet-Bearing Paragonite-Epidote Amphibolite in the Yuli Belt, Eastern Taiwan. Goldschmidt Conference, Yokohama, Japan. Goldschmidt Abstracts, 2016 3180.
- Webb, L.E.** and Klepeis, K.A., 2015, Punctuated melt-enhanced deformation and tectonic reactivation above a long-lived subduction zone, coastal Andes, central Chile, Geological Society of America Abstracts with Programs. Vol. 47, No. 7, p. 495.
- Baldwin, S.L., Malusà, M.G., Fitzgerald, P.G., **Webb, L.E.**, and, 2015, Deciphering the 4-d evolution of Cenozoic (U)HP terranes, Geological Society of America Abstracts with Programs. Vol. 47, No. 7, p. 168. **INVITED.**

- Fitzgerald, P.G., Baldwin, S.L., Bermúdez, M.B., **Webb, L.E.**, Little, T.A., Malusà, M.G., Miller, S.R., and Seward, D., 2015, Constraints from low-temperature thermochronology on exhumation of (U)HP terranes: the eastern Papuan New Guinea example, Geological Society of America Abstracts with Programs. Vol. 47, No. 7, p. 375.
- Lagor, S. and **Webb, L.E.**, 2015, Evidence for syntectonic intrusion of the Knox Mountain Pluton in the Connecticut Valley-Gaspe Trough, central Vermont, Geological Society of America Abstracts with Programs. Vol. 47, No. 3, p. 101.
- Baldwin, S.L., Fitzgerald, P.G., **Webb, L.E.**, and Malusà, M.G., 2015, The (U)HP terrane of eastern Papua New Guinea: a modern analogue for (U)HP terranes globally, XI International Eclogite Conference, Dominican Republic.
- Fitzgerald, P.G., Baldwin, S.L., Bermúdez, M.B., **Webb, L.E.**, Little, T.A., Miller, S.R., Malusà, M.G., and Seward, D., 2014, Exhumation of the Papuan New Guinea (U)HP terrane: Constraints from low temperature thermochronology, XI International Eclogite Conference, Dominican Republic.
- Baldwin, S.L., Bermúdez, M., Fitzgerald, P.G., and **Webb, L.E.**, 2014, Integrative thermochronology, petrology and modelling reveal the 4-D evolution of active plate boundary zones, 14th International Conference on Thermochronology, September 2014, Chamonix, France.
- Webb, L.E.**, Klepeis, K.A., Jones, D.A., Webber, J.R., Cembrano, J., Morata, D., Mora-Klepeis, G., and Arancibia, G., 2014, Thermochronologic Constraints on the Late Paleozoic and Early Mesozoic Tectonic Evolution of Coastal Central Chile (33.5 S), Geological Society of America Abstracts with Programs. Vol. 46, No. 6, p.445.
- Lagor, S., and **Webb, L.E.**, 2014, The relationship between magmatism, deformation, and metamorphism during the Acadian Orogeny: a case study from the Knox Mountain Pluton, Green Mountains, Vermont, Geological Society of America Annual Meeting, Vancouver, October, 2014.
- Webb, L.**, Dyess, P., Ashley, K., Spear, F., and Thomas, J., 2013, TitaniQ Records of P-T-D Paths from Metapelites during Burial Metamorphism and Orogenesis: Evidence for the Role of Pressure Solution Creep, (EOS, Transactions, American Geophysical Union).
- Baldwin, S., Moucha, R., Fitzgerald, P.G., Hoke, G.D., Bermudez, M.A., **Webb, L.E.**, Braun, J., Rowley, D.B., Insel, N., Abers, G.A., Wallace, L.M., and Vervoort, J.D., 2013, Linking mantle dynamics, plate tectonics and surface processes in the active plate boundary zones of eastern New Guinea (EOS, Transactions, American Geophysical Union). **INVITED**.
- Webb, L.**, Dyess, P., Ashley, K., Spear, F., and Thomas, J., 2013, Probing quartz for P-T-t-D paths, Mineralogical Magazine, 77(5) 2474. Goldschmidt Conference, Florence, Italy.
- Ashley K., Law R., Stahr D., Thomas J., Caddick M., Spear F., and **Webb L.**, 2013, Improved Crustal PTtD Evolution Constraints Using TitaniQ Thermobarometry, Mineralogical Magazine, 77(5) 624. Goldschmidt conference, Florence, Italy.
- Webb, L.E.**, Westerman, D.S., Springston, G.E., Kim, J., Klepeis, K., Koteas, G.C., *Ruksznis, A.*, Merhtens, C., Becker, L.R., and Gale, M., 2013, Field-based undergraduate curriculum and research exploring geophysical methods, with applications to the State of Vermont, (Geological Society of America Northeastern Section – 48th Annual Meeting).

- Dyess, P., Webb, L.E., Spear, F.S., and Thomas, J.B., 2012, Investigating Records of Prograde Metamorphism in Quartz with TitaniQ Thermobarometry: Initial Results from the Northfield Mountains, Vermont, (EOS, Transactions, American Geophysical Union).*
- Thomas, J.B., Spear, F.S., and **Webb, L.E.**, 2012, Experimental study of titanium-in-coesite solubility, (EOS, Transactions, American Geophysical Union).
- Baldwin, S.L., Fitzgerald, P.G., Bermudez, M.A., **Webb, L.E.**, Moucha, R., Miller, S.R., *Catalano, J.P.*, and *Zirakparvar, N.A.*, 2012, Linking deep earth to surface processes in the Woodlark Rift of Papua New Guinea; a framework for understanding (U)HP exhumation globally, (EOS, Transactions, American Geophysical Union).
- Fitzgerald, P.G., Baldwin, S.L., Bermudez, M.A., Miller, S.R., **Webb, L.E.**, and Little, T., 2012, Low-temperature thermochronologic constraints on cooling and exhumation trends along conjugate margins, within core complexes and eclogite-bearing gneiss domes of the Woodlark rift system of eastern Papua New Guinea, (EOS, Transactions, American Geophysical Union).
- Ashley K.T., Webb, L.E., Spear, F.S., and Thomas, J.B., 2012, P-T-D Histories and Reequilibration of Ti in Quartz: Using the TitaniQ Thermobarometer in Poly-Deformed Tectonic Terranes, Mineralogical Magazine, 1436, Goldschmidt conference, Montreal, Quebec, Canada.*
- Spear, F.S., *Ashley K.T.*, **Webb, L.E.**, and Thomas, J.B., 2012, Tectonic implications of short metamorphic episodes, Goldschmidt Conference, Montreal, Quebec, Canada.
- Ruksznis, A., Kim, J., Klepeis, K., and Webb, L.E., 2012, Integration of structural analysis, EMI, and GPR surveys, and hydrogeology in the Plainfield quadrangle, central Vermont, (Geological Society of America Northeastern Section – 47th Annual Meeting).*
- McNiff, C.M., Klepeis, K., Webb, L.E., and Kim, J., 2012, Geometric variability and spatial extent of an Acadian dome and basin fold interference pattern in NW Vermont, (Geological Society of America Northeastern Section – 47th Annual Meeting).*
- Webb, L.E.**, Taylor, J.P., Heumann, M.J., Johnson, C.L., *Stypula, M.J.*, and Kylander-Clark, A.R.C., 2011, Permo-Triassic collisional orogenesis and transition to intraplate sinistral shear in southeastern Mongolia, (EOS, Transactions, American Geophysical Union).
- Baldwin, S.L., *Zirakparvar, N.A.*, **Webb, L.E.**, Kula, J., Metcalf, J.R., Fitzgerald, P.G., and *Catalano, J.P.*, 2011, The isotopic record of subduction and exhumation within the (U)HP terrane of Papua New Guinea, 9th International Eclogite Conference, Czech Republic.
- Catalano, J.P.*, Baldwin, S.L., Fitzgerald, P.G., and **Webb, L.E.**, 2011, The isotopic record of subduction and exhumation within the (U)HP terrane of Papua New Guinea, 9th International Eclogite Conference, Czech Republic.
- Fitzgerald, P.G., Baldwin, S.L., Miller, S.R., Little, T.A., **Webb, L.E.**, Metcalf, J.R., and Perry, S.E., 2011, Apatite fission track and (U-Th)/He dating in the world's youngest UHP terrane: The Woodlark rift of southeastern Papuan New Guinea, *Mineralogical Magazine*, p. 852.
- Webb, L.E.**, *Taylor, J.P.*, *Heumann, M.J.*, Johnson, C.L., *Stypula, M.J.*, and *Hagen-Peter, G.A.*, 2010, Thermochronologic Records of Intraplate Deformation in the Northern East Gobi Fault Zone, Mongolia (EOS, Transactions, American Geophysical Union).
- Ashley K.T., Webb, L.E., Spear, F.S., and Thomas, J.B., 2010, Constraining P-T-t-D Histories with the TitaniQ Thermobarometer: Preliminary Findings from the Strafford Dome, Vermont (EOS, Transactions, American Geophysical Union).*

- Stypula, M.J., and Webb, L.E., 2010, Microstructural and U-Pb Zircon Constraints on the Relationship between Partial Melting and Ductile Shear in the East Gobi Fault Zone, Southeast Mongolia (EOS, Transactions, American Geophysical Union).*
- Baldwin, S., *Zirakparvar, N.A., Catalano, J.P., Fitzgerald, P.G., Webb, L.E., and Little, T., 2010, Reconstructing the Mid-Miocene to Recent evolution of the Woodlark Rift (EOS, Transactions, American Geophysical Union).*
- Catalano, J.P., Baldwin, S., Fitzgerald, P.G., Webb, L.E., and Hollocher, K., 2010, Temporal and geochemical constraints on active volcanism in southeastern Papua New Guinea (EOS, Transactions, American Geophysical Union).*
- Baldwin, S.L., **Webb, L.E.**, Fitzgerald, P.G., *Zirakparvar, N.A., and Catalano, J.P., 2010, From subduction to rifting: The Late Cretaceous–Cenozoic tectonic evolution of eastern Papua New Guinea, (Tectonic Crossroads: Evolving Orogens of Eurasia-Africa-Arabia, Ankara, Turkey, Paper No. 32-3), INVITED.*
- Webb, L.E.**, Baldwin, S.L., *Zirakparvar, N.A., Fitzgerald, P.G., and Catalano, J.P., 2010, From microstructures to microplates: Integrating across scales to constrain the plate boundary evolution in eastern Papua New Guinea (AGU Western Pacific Meeting, V44A-02). INVITED.*
- Webb, L.E.**, Baldwin, S.L., Fitzgerald, P.G., *Castellan, L., and Zirakparvar, N.A., 2009, Structural Analysis of the Louisiade Archipelago, Southeastern Papua New Guinea (EOS, Transactions, American Geophysical Union).*
- Taylor, J.P., Webb, L.E., Johnson, C.L., Heumann, M.J., Hagen-Peter, G.A., and Gehrels, G.E., 2009, Testing the Existence of the South Gobi Microcontinent: U-Pb Zircon Dating of Tectonites within the East Gobi Fault Zone, Southeastern Mongolia (EOS, Transactions, American Geophysical Union).*
- Stypula, M., Webb, L.E., and Hagen-Peter, G.A., 2009, Evidence for partial melting at northern Tavan Har and relationship to Late Triassic sinistral shear in the East Gobi Fault Zone, southeastern Mongolia (EOS, Transactions, American Geophysical Union).*
- Hagen-Peter, G.A., Webb, L.E., and Stypula, M., 2009, Large-scale folding in the Tavan Har basement block, southeastern Mongolia and its relevance to Phanerozoic intracontinental deformation (EOS, Transactions, American Geophysical Union).*
- Heumann, M.J., Johnson, C.L., Webb, L.E., Taylor, J.P., 2009, Mesozoic–Cenozoic Reconstruction of the East Gobi Fault Zone, Southern Mongolia (EOS, Transactions, American Geophysical Union).*
- Taylor, J.P., Webb, L.E., Johnson, C.L., Heumann, M.J., 2009, Strike-slip and exhumation history of the East Gobi Fault Zone, southeastern Mongolia, with emphasis on the Cenozoic era (Geological Society of America Abstracts with Programs, Geological Society of America Abstracts with Programs).*
- Taylor, J.P., Webb, L.E., Fitzgerald, P.G., Johnson, C.L., Heumann, M.J., 2008, Constraints on the Low Temperature Thermal History of the Tsagan Subarga and Tavan Har Basement Blocks of the East Gobi Fault Zone, Southeastern Mongolia, and Tectonic Implications (EOS, Transactions, American Geophysical Union).*
- Heumann, M.J., Johnson, C.L., Webb, L.E., Taylor, J.P., 2008, Detrital zircon and sandstone provenance analysis from Permian and Lower Cretaceous sedimentary units to constrain total and incremental left-lateral offset along the East Gobi Fault Zone, southeastern Mongolia (EOS, Transactions, American Geophysical Union).*

- Baldwin, S.L., Little, T.A., **Webb, L.E.**, Fitzgerald, P.G., *Zirakparvar, A.* and *Peters, K.*, 2008, Metamorphic Core Complex Formation on Misima Island during Miocene-Pliocene Rifting and Seafloor Spreading in the Woodlark Basin, Papua New Guinea, SE Papua New Guinea (EOS, Transactions, American Geophysical Union).
- Waggoner, A.G.*, Baldwin, S.L., **Webb, L.E.**, Little, T.A., and Fitzgerald, P.G., 2008, Temporal Constraints on Continental Rifting and the Exhumation of Pliocene Eclogites, SE Papua New Guinea (EOS, Transactions, American Geophysical Union).
- Fitzgerald, P.G., Baldwin, S.L., Miller, S.R., *Perry, S.E.*, **Webb, L.E.**, and Little, T.A., 2008, Low-Temperature Constraints on the Evolution of Metamorphic Core Complexes of the Woodlark Rift System, Southeastern Papua New Guinea (EOS, Transactions, American Geophysical Union).
- Webb, L.E.**, Baldwin, S.L., Little, T.A., and Fitzgerald, P.G., 2008, Is Microplate Rotation Driving HP–UHP Exhumation in Eastern Papua New Guinea? (Geological Society of America *Abstracts with Programs*, Geological Society of America Abstracts with Programs, v. 40, n. 6, p. 551). **INVITED.**
- Webb, L.E.**, Johnson, C.L., Minjin, C., 2007, Thermochronology of early Mesozoic shear in the East Gobi Fault Zone, Mongolia (EOS, Transactions, American Geophysical Union).
- Taylor, J.P.*, **Webb, L.E.**, Johnson, C.L., *Heumann, M.J.*, 2007, Constraints on Mesozoic and Tertiary Brittle Faulting in the Southern East Gobi Fault Zone, Southeastern Mongolia (EOS, Transactions, American Geophysical Union).
- Seiple, I.L.*, **Webb, L.E.**, *Taylor, J.P.*, *Heumann, M.J.*, Johnson, C.L., Minjin, C., 2007, Early Mesozoic overprinting of Paleozoic protoliths during shear zone formation in the southeast Gobi, Mongolia (EOS, Transactions, American Geophysical Union).
- Heumann, M.J.*, Johnson, C.L., **Webb, L.E.**, *Taylor, J.P.*, 2007, Implications for Mesozoic to Modern Tectonic Deformation in Sub-Basins Along the East Gobi Fault Zone, Southern Mongolia (EOS, Transactions, American Geophysical Union).
- Baldwin, S.L., **Webb, L.E.**, *Monteleone, B.D.*, 2007, Late Miocene coesite-eclogite exhumed in the Woodlark Rift, Papua New Guinea (EOS, Transactions, American Geophysical Union).
- Beamud, E., Fitzgerald, P., Muñoz, J., Garces, M., Baldwin, S., Webb, L., *Schwabe, E.*, and Cabrera, L., 2007 Palaeogene Exhumation of the Pyrenean Orogen: Magnetostratigraphic and Thermochronological Constraints from the South-Central Pyrenees (EOS, Transactions, American Geophysical Union).
- Webb, L.E.**, and Johnson, C.L., 2006, Intraplate Deformation Phase I of the East Gobi Fault Zone, Mongolia: Early Mesozoic Sinistral Shear (Geological Society of America *Abstracts with Programs*, Geological Society of America Abstracts with Programs, v. 38, n. 7, p. 418).
- Baldwin, S.L., *Monteleone, B.D.*, Little, T.A., **Webb, L.E.**, and Fitzgerald, P.G., 2006, Subduction to rifting evolution of the Australian–Woodlark plate boundary zone of eastern Papua New Guinea: insights into the 4-D nature of continental subduction and exhumation processes (Geological Society of America *Abstracts with Programs*, v. 38, n. 7, p. 274).
- Webb, L.E.**, Johnson, C.L., G. Badarch, Ch. Minjin, G. Sersmaa, 2006, Evidence for an early Mesozoic mylonitic sinistral shear zone in southeastern Mongolia, IGCP 480 (International Geological Congress), Structural and Tectonic Correlation across the Central Asia Orogenic Collage, Ulaanbaatar, Mongolia, July 2006, Extended Abstracts Volume, p. 43-45.

- Johnson, C.L., Amory, J.A., Zinniker, Z., Lamb, M.A., G. Badarch, and **Webb, L.E.**, 2006, Sedimentary record of arc collision, Permian, southern Mongolia, IGCP 480 (International Geological Congress), Structural and Tectonic Correlation across the Central Asia Orogenic Collage, Ulaanbaatar, Mongolia, July 2006, Extended Abstracts Volume, p. 46-49.
- Baldwin, S.L., **Webb, L.E.**, *Monteleone, B.*, Little, T.A., Fitzgerald, P.G., *Peters, K.*, Chappell, J.L., 2006, Continental crust subduction and exhumation: Insights from eastern Papua New Guinea, *Geochimica et Cosmochimica Acta Supplement*, v. 70, issue 18, p. 31.
- Baldwin, S.L., **Webb, L.E.**, and *Monteleone, B.*, Little, T.A., Fitzgerald, P.G., and Chappell, J.L., 2005, Metamorphism and exhumation of the youngest known HP/UHP terrane on Earth, eastern Papua New Guinea, (EOS, Transactions, American Geophysical Union; v. 86 (52)).
- Leech, M.L., **Webb, L.E.**, and Yang, T., 2005, Diachronous histories for the Dabie-Sulu orogen from high-temperature geochronology (*Geological Society of America Abstracts with Programs*, v. 37, n. 7, p. 57)
- Affolter, M.D.*, Johnson, C.L., and **Webb, L.E.**, 2005, Tectonic History of the East Gobi Basin (*Geological Society of America Abstracts with Programs*, v. 37, n. 7, p. 442).
- Fitzgerald, P., Baldwin, S., Muñoz, J.-A., **Webb, L.**, and *Schwabe, E.*, 2005, Exhumation of the Pyrean intracontinental collisional orogen: New thermochronologic constraints from the central Pyrenees (*Geological Society of America Abstracts with Programs*, v. 37, n. 7, p. 346)
- Webb, L.E.**, Baldwin, S.L., Little, T.A., and Fitzgerald, P.G., 2005, A pivoting microplate model for subduction eversion and exhumation of UHP terranes (7th International Eclogite Conference, Austria, *Mitt.Österr.Miner.Ges.* 150, p. 164).
- Baldwin, S.L., **Webb, L.E.**, and *Monteleone, B.*, 2005, Late Miocene–Pliocene eclogites of eastern Papua New Guinea: the youngest known HP/UHP terrane on Earth (7th International Eclogite Conference, Austria, *Mitt.Österr.Miner.Ges.* 150, p.16).
- Monteleone, B.*, Baldwin, S., **Webb, L.** & Fitzgerald, P., 2005, Constraints on Eclogite Facies Metamorphism in Southeastern Papua New Guinea from in situ Ion Microprobe U-Pb and REE Analyses (15th Annual Goldschmidt Conference, Abstract Volume, A60).
- Johnson, C.L., and **Webb, L.E.**, 2005, Cenozoic Reactivation of the East Gobi Fault Zone, 20th Symposium, Himalaya-Karakorum-Tibet Workshop (HKT20), Aussois, France, (*Geologie Alpine, Memoire H.S.*, n. 44, p.94-95).
- Webb, L.E.**, Johnson, C.L., Minjin, Ch., Sersmaa, G., *Affolter, M.*, and *Manchuk, N.*, 2004, Mesozoic and Cenozoic Intracontinental Deformation in Southeastern Mongolia, (EOS, Transactions, American Geophysical Union, v. 85 (47), F1698).
- Johnson, C.L., **Webb, L.E.**, Minjin, Ch., Sersmaa, G., *Affolter, M.*, and *Manchuk, N.*, 2004, Sedimentary Basin Evolution in the Context of Polyphase Intracontinental Deformation: New Insights from Southeastern Mongolia, (EOS, Transactions, American Geophysical Union; v. 85 (47), F1699).
- Baldwin, S.L., Finn, C.A., **Webb, L.E.**, Fitzgerald, P.G., Little, T., and Anderson, E., 2004, Microplate rotation leads to rapid exhumation of a subduction complex in eastern Papua New Guinea (EOS, Transactions, American Geophysical Union; v. 85 (47), F1738).
- Monteleone, B.*, Baldwin, S.L., Little, T., Fitzgerald, P.G., and **Webb, L.E.**, 2004, Thermochronologic and Geochemical Investigations of High Pressure Metamorphism and Pliocene Exhumation of the D'Entrecasteaux Islands, Southeastern Papua New Guinea (EOS, Transactions, American Geophysical Union; v. 85 (47), F1737).

- Baldwin, S.L. **Webb, L.E.**, and Fitzgerald, P.G., 2004, Rifting of a subduction complex in eastern Papua New Guinea leads to exhumation of Pliocene HP rocks at plate tectonic rates (32nd International Geologic Congress, Florence, Italy, August 2004).
- Leech, M.L., **Webb, L.E.**, Yang, T., Xu, Z., 2003, Microstructural analysis of the ultrahigh-pressure Sulu Terrane, eastern China (EOS, Transactions, American Geophysical Union; v. 84, F1391).
- Baldwin, S.L. P.G. Fitzgerald, T.A. Little, **L.E. Webb** and *B.D. Monteleone*, 2003, Exhumation of the youngest HP rocks, at plate tectonic rates, during Plio-Pleistocene continental extension in SE Papua New Guinea (Geological Society of America *Abstracts with Programs*, v. 35, no. 6, p. 556).
- Webb, L.E.**, Leech, M.L., Yang, T., Xu, Z., 2002, Kinematics of structures of the ultrahigh-pressure Sulu Terrane, eastern China (EOS, Transactions, American Geophysical Union; v. 83, F1245).
- Fitzgerald, P., Baldwin, S., Farley, K., Hedges, L., O'Sullivan, P. and **Webb, L.**, 2002, Constraining landscape evolution of the West Antarctic rift flank of southern Victoria Land (Abstracts of the 12th annual V. M. Goldschmidt conference, *Geochimica et Cosmochimica Acta* v. 66, no. 15A, p. 235).
- Fitzgerald, P.G., Baldwin, S.L., Farley, K.A., Hedges, L., O'Sullivan, P.B., and **Webb, L.E.**, 2001, Exhumation of apatite helium partial retention zones: An example from the Transantarctic Mountains and implications for (U/Th)/He dating of apatites (Geological Society of America *Abstracts with Programs*, v. 33).
- Ritts, B.D., Graham, S.A., **Webb, L.E.**, Chang, E., Hanson, A., Johnson, C.L., 2000, Late Mesozoic Extrusion Tectonics of the North China Block (EOS, Transactions, American Geophysical Union; v. 81).
- Anderson, K.S., and others, 1998, The Wagon Rock Project; an interdisciplinary characterization of sand-rich, high-density turbidity current deposits of the "Merle Formation", northern Santa Lucia Range, California (American Association of Petroleum Geologists annual meeting, Salt Lake City, Utah).
- Hendrix, M.S., Beck, M. A., Lenegan, R., Graham, S. A., Johnson, C. J., **Webb, L.**, and Sjostrom, D. J., 1998, Early Mesozoic development of a regional lake system in southern Mongolia: American Association of Petroleum Geologists National Meeting, Salt Lake City, Utah.
- Hendrix, M.S., Beck, M.A., Graham, S. A., Johnson, C. J., and **Webb, L.**, 1998, Early Mesozoic development of a regional lake system in southern Mongolia - sedimentary signature of a collisional foreland style basin? Yinshan-Yanshan major thrust and nappe structures field conference, May 8-11, Hohhot, Nei Mongol, China.
- Greene, T.J., Ritts, B.D., **Webb, L.E.**, Graham, S.A.; Johnson, C.L., Hourigan, J.L., 1997. Progress report on Mesozoic Asian studies conducted by Stanford University (Geological Society of America *Abstracts with Programs*, v. 29).
- Hacker, B.R., Ratschbacher, L., **Webb, L.E.**, Ireland, T., Walker, D., Calvert, A., Dong, S., 1997. New Constraints on Exhumation of Ultrahigh-Pressure Rocks, Dabie–Hong'an–Tongbai Shan, China (Geological Society of America *Abstracts with Programs*, v. 29).
- Johnson, C.L., Graham, S.A., **Webb, L.E.**, Badarch, G., Hendrix, M., Sjostrom, D., Beck, M., and Lenegan, R., 1997. Sedimentary response to late Mesozoic extension in southern Mongolia (EOS, Transactions, American Geophysical Union; v. 78). *INVITED*.
- Webb, L.E.**, Graham, S.A., Johnson, C.L., Badarch, G., Hendrix, M., Sjostrom, D., Beck, M., and Lenegan, R., 1997. Characteristics and implications of the Onch Hayrhan metamorphic core

complex of southern Mongolia (EOS, Transactions, American Geophysical Union; v. 78).
INVITED.

Webb, L.E., Hacker, B.R., Ratschbacher, L., Leech, M. Dong, S., and Lianhong, P., 1997. Mesozoic tectonism in the Qinling–Dabie collisional orogen: New constraints on the multistage exhumation of ultrahigh-pressure rocks (Geological Society of America *Abstracts with Programs*, v. 29). **INVITED.**

Webb, L.E., Hacker, B.R., Ratschbacher, L., and Dong S., 1996. Structures, and kinematics of exhumation; ultrahigh-pressure rocks in the Hong'an Block of Qinling–Dabie Orogen, China (Geological Society of America *Abstracts with Programs*, v. 28).

Webb, L.E., Hacker, B.R., Ratschbacher, L., and Dong S., 1996. Structural and geochronological constraints on the exhumation of high- and ultrahigh-pressure rocks in the Qinling–Dabie Orogen, China. (Penrose Conference: Exhumation Processes: Normal Faulting, Ductile Flow, and Erosion. Penrose Conference, Greece.)

Hacker, Bradley R., Ratschbacher, L., **Webb, L.E.,** and Dong S., 1995, What brought them up? Exhumation of ultrahigh-pressure rocks in the Dabie Mountains of eastern China. (EOS, Transactions, American Geophysical Union; v. 76).

Webb, L.E., Hacker, B.R., Ratschbacher, L., and Dong S., 1995, Structures and kinematics of exhumation from 40 km; the Dabie Shan ultrahigh-pressure rocks, E. China (Geological Society of America *Abstracts with Programs*, v. 27).

GRADUATE ADVISING

Kristin Schnalzer (BS SUNY Plattsburgh), University of Vermont, MS in Geology, 2020 expected. Investigating the timing of deformation in the Chester Dome with $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology.

Cheyne Aiken (BS SUNY Potsdam), University of Vermont, MS in Geology, October 2018. Geochronologic Constraints on the Timing of Metamorphism and Exhumation of the Tillotson Peak Complex in Northern Vermont.

Evan Tam (BS University of Connecticut), University of Vermont, MS in Geology, October 2018. Geochronological Constraints on the Timing of Deformation: An Examination of the Prospect Rock Fault Footwall in North-Central Vermont.

Samuel Lagor (BS St. Lawrence University), University of Vermont, MS in Geology, May 2016. The relationship between magmatism, deformation, and metamorphism during the Acadian orogeny: A case study from the Knox Mountain pluton, Green Mountains, Vermont.

Patrick Dyess (BS Montana State University), University of Vermont, MS in Geology, October 2013. Interpreting Quartz Textures through TitanQ Thermobarometry of Low Grade Metapelites, Northfield Mountains, Vermont. Went on to work with NTL Engineering and Geoscience, Inc.

Christine Downs (BS Salem State University), University of Vermont, MS in Geology, October 2012. The Characterization of Ductile Deformation in the Upper and Lower Plates of the Hinesburg Thrust Fault Through Detailed Geometric Analysis of Selected Outcrops. Currently a PhD student at University of Southern Florida.

Merril Stypula (BA Colorado College), University of Vermont, MS in Geology, May 2012. U-Pb Zircon Dating of Metamorphic Tectonites from Tavan Har, Southeast Mongolia: Implications for the Role of Tectonic Inheritance in Intraplate Shear Zones. Currently employed by EQT Corporation.

Kyle Ashley (BS SUNY Potsdam), University of Vermont, MS in Geology, October 2011. TitanQ Thermobarometry of Fabric Development in the Strafford Dome, Vermont: Linking Microstructures to Orogenic Processes. Went on to a PhD program at Virginia Tech, post-doc at UT Austin, and now a visiting professor at University of Pittsburgh.

Joshua Taylor, (BS St. Lawrence University, MS Syracuse University), Syracuse University, PhD in Earth Sciences (co-advisor with P.G. Fitzgerald), May 2011. Tectonic History of the East Gobi Fault Zone, Southeastern Mongolia: An Integrated Study Using Structural Geology, Geochronology, and Thermochronology. Currently employed at ExxonMobil Exploration Company.

GRADUATE STUDENT THESIS COMMITTEES

John Mark Brigham, Syracuse University, Department of Earth Sciences. MS, 2019 expected. Mineralogy of the Partially Serpentinized Meta-Dunite in East Dover, Vermont. Advisor: Suzanne Baldwin.

Joseph Gonzales, Syracuse University, Department of Earth Sciences. PhD, 2019 expected. Petrology and Thermochronology of the Burgess Branch Fault Zone at the Tillotson Peak Complex, Vermont. Advisor: Suzanne Baldwin.

Caswell, Brandon, University of Idaho, MS, 2018. $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronology of Biotite from Ductile Shear Zones of the Ellesmere-Devon Crystalline Terrane, Nunavut, Canadian Arctic. Advisor: Jane Gilotti.

Matthew Merson, University of Vermont, Department of Geology, MS, 2018. The Spatial and Temporal Development of the Champlain Thrust Fault Zone Exposed in Northwest Vermont. Advisor: Keith Klepeis.

Maquire IV, Henry, MS, 2018. Application of Geostatistical and Geochronological Methods to Stratigraphic Problems in the Lower Cambrian Monkton Formation. Advisor: Charlotte Mehrtens.

Julia Runcie, University of Vermont, Ecological Planning Program, Rubenstein School of Environment and Natural Resources. MS, 2017. Environmental assessment guiding recreation at Travertine Hot Springs ACEC. Advisor: Dean Wang

Gina Accorsi, University of Vermont, Department of Geology, MS, 2017. Geochemical and XRD fingerprinting of conflict minerals, Advisor: John M. Hughes.

Mike Ingram, University of Vermont, Department of Geology, MS, 2016. The Effects of Heterogeneity in the Lower Crust on Strain Partitioning and Fabric Development During Extension Doubtful Sound, New Zealand. Advisor: Keith Klepeis.

John Gilbert, University of Vermont, Department of Geology, MS, 2016 expected. Crustal deformation during arc-flare up magmatism: Field and microstructural analysis of a mid-crustal, melt-enhanced shear zone. Advisor: Keith Klepeis.

Hannah Blatchford, University of Vermont, Department of Geology, MS, 2016. Fiordland, New Zealand. The Structural Evolution of a Portion of the Median Batholith and Its Host Rock in Central Fiordland, New Zealand: Examples of Partitioned Transpression and Structural Reactivation. Advisor: Keith Klepeis.

Benjamin Melosh, McGill University, Department of Earth and Planetary Sciences, PhD, 2015. Earthquake cycling in the brittle-plastic transition of a transform boundary: The Pofadder Shear Zone, Namibia and South Africa. Advisor: Christie Rowe.

- Myagmarjav Lkhagvasuren, University of Vermont, Wildlife and Fisheries Biology Program Rubenstein School of Environment and Natural Resources, MS, 2015. Effects of Landscape Characteristics on Carnivore Diversity in Mongolia. Advisor: James Murdoch.
- Ryan Brink, University of Vermont, Department of Geology, MS, 2014. Sedimentologic Comparison of the Late/Lower Early Middle Cambrian Altona Formation and the Lower Cambrian Monkton Formation. Advisor: Char Mehrtens.
- Kathryn Dianiska, University of Vermont, Department of Geology, MS, 2014. The Interplay Between Deformation and Metamorphism During Strain Localization in the Lower Crust: Insights from Fiordland, New Zealand. Advisor: Keith Klepeis.
- Alice Newman, University of Vermont, Department of Geology, MS, 2014. Strain Localization and Exhumation of the Lower Crust: A Study of the Three-Dimensional Structure and Flow Kinematics of Central Fiordland, New Zealand. Advisor: Keith Klepeis.
- Jacob Menken, University of Vermont, Department of Geology, MS, 2014. Effect of Thermal Treatment on the Cation Exchange and Disordering in Tourmaline. Advisor: John Hughes.
- Stephanie Perry, Syracuse University, Department of Earth Sciences, PhD, 2014. Thermotectonic Evolution of the Alaska Range: Low-temperature Thermochronologic Constraints. Advisor: Paul Fitzgerald.
- Jeffrey Webber, University of Vermont, Department of Geology, MS, 2012. Advances in Rock Fabric Quantification and the Reconstruction of Progressive Dike Emplacement in the Coastal Batholith of Central Chile. Advisor: Keith Klepeis.
- Jessica Terrien, Syracuse University, Department of Earth Sciences, PhD, 2012, dissertation in progress. Thermochronology and Geophysical Modeling of the Santa Catalina Metamorphic Core Complex, Arizona. Advisor: Suzanne Baldwin.
- Charles Trodick, University of Vermont, Department of Geology, MS, 2011. Sediment Generation Rates in the Potomac River Basin. Advisor: Paul Bierman.
- Eric Portenga, University of Vermont, Department of Geology, MS, 2010. Using ^{10}Be to constrain erosion rates of bedrock outcrops globally and in the central Appalachian Mountains. Advisor: Paul Bierman.
- Janelle McAtamney, University of Vermont, Department of Geology, MS, 2010. Synthesizing the tectonic evolution of the Magallanes foreland basin during the Late Cretaceous backarc basin inversion using structural and stratigraphic evidence from Bahia Brookes, southern Patagonia, Chile. Advisor: Keith Klepeis.
- Matthew Heumann, University of Utah, Department of Geology and Geophysics, PhD, 2010. Tectonic history and subsequent basin development along the East Gobi Fault Zone in southeastern Mongolia. Advisor: Cari Johnson.
- Brian Monteleone, Syracuse University, Department of Earth Sciences, PhD, 2006. Timing and conditions of formation of the D'Entrecasteaux Islands, Southeastern Papua New Guinea. Advisor: Suzanne Baldwin.

ADVISING OF UNDERGRADUATE RESEARCH

- Eryka Collins and John Sawyer Shaw, Geology BS, 2019 expected. Microstructural analyses and $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology of the Rattlesnake Thrust, southern Vermont.
- Samantha Portnoy, Geology BS, 2018. Relationship between rapid exhumation and fault patterns in Fiordland, New Zealand. Co-advising with Keith Klepeis.

- Patrick Sullivan, University of Vermont, Geology BS, 2017. Structural analysis and geochronology of pseudotachylyte in the Taconic Arrowhead Mountain thrust fault zone.
- Elizabeth Pidgeon, University of Vermont, Geology BS, 2017. Subduction–exhumation-related deformation of high-pressure rocks, Tillotson Peak, Vermont.
- Mariah Schneider, University of Vermont, Geology, BS, 2016. Geo-archaeological investigation of the UVM Green using ground penetrating radar, electromagnetic induction, and seismic refraction profiling.
- Edward Bonner, University of Vermont, Geology, BS, 2016. Geo-archaeological investigation of the UVM Green using ground penetrating radar, electromagnetic induction, and seismic refraction profiling.
- Carson Mitchell, University of Vermont, Geology, Geology BS, 2016. Field investigation of the Arrowhead Mountain Thrust Fault in the Lamoille River region.
- Andrew Goff, University of Vermont, Geology, BS, 2015. Acadian Deformation in the Connecticut Valley Trough: Investigating Penetrative S_2 Foliation Development in the Waits River Formation.
- Jacob Vincent, University of Vermont, Geology, BS, 2014. Structural analysis of Acadian deformation the Dog River Fault Zone, Montpelier, Vermont.
- Stefan Christie, University of Vermont, Geology, BS, 2014. Geophysical investigation of the Kent Island Formation within the Blackwater National Wildlife Refuge and the potential influence of glacioisostatic adjustment on the Mid-Atlantic. This project is in collaboration with Ben DeJong, UVM PhD student.
- Karina Heffernan, University of Vermont, Geology, BS, 2014. Geological and geophysical investigations of possible karst structures in the Dunham Dolomite, Starksboro, Vermont. This project is in collaboration with the Vermont Geological Survey.
- Parker Richmond, University of Vermont, Geology, BS, 2013. Ground-penetrating radar investigation of fractures at Shelburne Point and Mount Philo, Vermont. Field studies advised in Summer and Fall 2012, Spring 2013.
- James Christiansen, University of Vermont, Geology, BS, 2012. Metamorphism of arc and forearc lithologies at Tavan Har, SE Mongolia. Spring 2012.
- Nick Archer, University of Vermont, Environmental Sciences, BS, 2012. Electromagnetic induction profiling of the Waits River Formation in Calais and East Montpelier, Vermont. Fall 2011. This project is in collaboration with the Vermont Geological Survey.
- Ted Crook, University of Vermont, Department of Geology, BS, 2011. Groundwater investigation in Craftsbury, Vermont, using integrated geophysical technologies. Fall 2010–Spring 2011. This project was in collaboration with the Vermont Geological Survey.
- Michael Ingram, University of Vermont, Department of Geology, BS, 2011. Interpretation of a Simple Bouguer Gravity Anomaly in Chittenden County, Vermont. Advising period: Fall 2010–Spring 2011. This project was in collaboration with the Vermont Geological Survey and Norwich University. Mike is currently an MS student in the Department of Geology at the University of Vermont.
- Hagen-Peter, Graham, University of Vermont, Department of Geology, BS, 2010. “Large Scale Folding in the Tavan Har Basement Block, Southeastern Mongolia: Implications for Intracontinental Deformation”. Advising period: Summer 2009–Spring 2010. Research presented at 2009 American Geophysical Union Fall Meeting, 2010 UVM Student Research

Conference and Spring 2010 Vermont Geological Society Meeting. Graham is currently a PhD student at the Institute for Crustal Studies, University of California, Santa Barbara.

Hefferon, Donald, University of Vermont, Department of Geology, BS, 2011. "Petrographic and Geochemical Analysis of Basement Rocks in the East Gobi Fault Zone, Mongolia." Advising period: Fall 2009–Spring 2010. Research presented at the 2010 Vermont Geological Society Meeting.

Gladstein, Katie, University of Vermont, Department of Geology, BS, 2009. "Volcanic Deformation Analysis of Mount Etna, Sicily, 2007–2008". Advising period: Spring 2009. Field data collected by K. Gladstein was under the supervision of John Murray at The Open University, United Kingdom. Research presented at the 2009 UVM Student Research Conference and Spring 2009 Vermont Geological Society Meeting.

Semple, Ian, Syracuse University, Department of Earth Sciences, BS, Spring 2008. "Early Mesozoic overprinting of Paleozoic protoliths during shear zone formation in the southeast Gobi, Mongolia". Advising period: Summer–Fall 2007. Supported by National Science Foundation Research Experience for Undergraduates supplement to grant EAR-0537165.

EXHIBIT B

Previous Four Years of Expert Testimony for Laura Webb, Ph.D.

Dr. Laura Webb has not testified as an expert at trial or by deposition during the previous four years.

Exhibit F

Laura Webb, Ph.D.

Page 1

UNITED STATES DISTRICT COURT

DISTRICT OF NEW JERSEY

-----x

IN RE JOHNSON & JOHNSON) MDL No.
TALCUM POWDER PRODUCTS) 16-2738 (FLW)(LHG)
MARKETING SALES PRACTICES,)
AND PRODUCTS LIABILITY)
LITIGATION)
)
THIS DOCUMENT RELATES TO)
ALL CASES)

-----x

VIDEOTAPED DEPOSITION OF

LAURA WEBB, Ph.D.

BURLINGTON, VERMONT

FRIDAY, MARCH 29, 2019

9:28 A.M.

Reported by: Leslie A. Todd

Laura Webb, Ph.D.

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<p>1 Deposition of LAURA WEBB, Ph.D., held at the:</p> <p>2</p> <p>3</p> <p>4 HOTEL VERMONT</p> <p>5 41 Cherry Street</p> <p>6 Burlington, Vermont 05401</p> <p>7 (802) 651-0080</p> <p>8</p> <p>9</p> <p>10</p> <p>11</p> <p>12</p> <p>13</p> <p>14 Pursuant to notice, before Leslie Anne Todd,</p> <p>15 Court Reporter and Notary Public, who officiated</p> <p>16 in administering the oath to the witness.</p> <p>17</p> <p>18</p> <p>19</p> <p>20</p> <p>21</p> <p>22</p> <p>23</p> <p>24</p> <p>25</p>	<p>1 APPEARANCES (Continued):</p> <p>2</p> <p>3 ON BEHALF OF THE JOHNSON & JOHNSON DEFENDANTS:</p> <p>4 JACK N. FROST, JR., ESQUIRE</p> <p>5 KATHERINE McBETH, ESQUIRE</p> <p>6 DRINKER BIDDLE & REATH LLP</p> <p>7 One Logan Square</p> <p>8 Suite 2000</p> <p>9 Philadelphia, Pennsylvania 19103-6996</p> <p>10 (215) 988-2706</p> <p>11</p> <p>12 ALEX V. CHACHKES, ESQUIRE</p> <p>13 ORRICK, HERRINGTON & SUTCLIFFE LLP</p> <p>14 51 West 52nd Street</p> <p>15 New York, New York 10019-6142</p> <p>16 (212) 506-3748</p> <p>17</p> <p>18 ON BEHALF OF THE PCPC:</p> <p>19 JAMES R. BILLINGS-KANG, ESQUIRE</p> <p>20 SEYFARTH SHAW LLP</p> <p>21 975 F Street, N.W.</p> <p>22 Washington, D.C. 20004-1454</p> <p>23 (202) 463-2400</p> <p>24</p> <p>25</p>
Page 3	Page 5
<p>1 APPEARANCES</p> <p>2</p> <p>3 FOR THE PLAINTIFFS:</p> <p>4 WARREN BURNS, ESQUIRE</p> <p>5 MARTIN D. BARRIE, J.D., Ph.D</p> <p>6 AMANDA KLEVORN, ESQUIRE</p> <p>7 BURNS CHAREST LLP</p> <p>8 900 Jackson Street</p> <p>9 Suite 500</p> <p>10 Dallas, Texas 75202</p> <p>11 (469) 904-4550</p> <p>12</p> <p>13 LEIGH O'DELL, ESQUIRE</p> <p>14 JENNIFER K. EMMEL, ESQUIRE (Telephonically)</p> <p>15 BEASLEY, ALLEN, CROW, METHVIN,</p> <p>16 PORTIS & MILES, P.C.</p> <p>17 218 Commerce Street</p> <p>18 Montgomery, Alabama 36104</p> <p>19 (334) 269-2343</p> <p>20</p> <p>21 STEVE FARIES, ESQUIRE</p> <p>22 MUELLER LAW, LLC</p> <p>23 404 West 7th Street</p> <p>24 Austin, Texas 78701</p> <p>25 (832) 293-7368</p>	<p>1 APPEARANCES (Continued):</p> <p>2</p> <p>3 ON BEHALF OF PHARMATECH INDUSTRIES (PTI):</p> <p>4 MICHAEL ANDERTON, ESQUIRE</p> <p>5 TUCKER ELLIS, LLP</p> <p>6 950 Main Avenue, Suite 1100</p> <p>7 Cleveland, Ohio 44113-7213</p> <p>8 (216) 696-4835</p> <p>9</p> <p>10 ALSO PRESENT:</p> <p>11 DAVID LANE, Videographer</p> <p>12</p> <p>13</p> <p>14</p> <p>15</p> <p>16</p> <p>17</p> <p>18</p> <p>19</p> <p>20</p> <p>21</p> <p>22</p> <p>23</p> <p>24</p> <p>25</p>

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<p style="text-align: right;">Page 11</p> <p>1 PROCEEDINGS</p> <p>2 -----</p> <p>3 THE VIDEOGRAPHER: We're now on the</p> <p>4 record. My name is David Lane, videographer for</p> <p>5 Golkow Litigation Services. Today's date is</p> <p>6 March 29th, 2019. Our time is 9:28 a.m.</p> <p>7 This deposition is taking place in</p> <p>8 Burlington, Vermont, in the matter of Talcum</p> <p>9 Powder Litigation MDL.</p> <p>10 Our deponent today is Laura Webb, Ph.D.</p> <p>11 Counsel will be noted on the</p> <p>12 stenographic record.</p> <p>13 Our court reporter today is Leslie Todd,</p> <p>14 who will now swear in the witness.</p> <p>15 LAURA WEBB, Ph.D.,</p> <p>16 and having been first duly sworn,</p> <p>17 was examined and testified as follows:</p> <p>18 THE VIDEOGRAPHER: You can begin.</p> <p>19 MR. BURNS: You want appearances on the</p> <p>20 record or --</p> <p>21 THE VIDEOGRAPHER: You can just begin.</p> <p>22 MR. BURNS: Okay. Thank you.</p> <p>23 Dr. Webb, before we get started -- and,</p> <p>24 Mr. Frost, this is directed to all -- we're going</p> <p>25 to lodge an objection on the record related to the</p>	<p style="text-align: right;">Page 13</p> <p>1 DIRECT EXAMINATION</p> <p>2 BY MR. BURNS:</p> <p>3 Q Good morning, Dr. Webb. My name is</p> <p>4 Warren Burns. Again, we met right before the</p> <p>5 deposition. I represent the plaintiffs in the</p> <p>6 MDL. I'm from Dallas, Texas, and I will be</p> <p>7 questioning you today.</p> <p>8 Dr. Webb, have you ever been deposed</p> <p>9 before?</p> <p>10 A I have not.</p> <p>11 Q Okay. A couple of simple rules for the</p> <p>12 road then. If you need a break, I'm more than</p> <p>13 willing to let you take one at any time. I only</p> <p>14 ask that if a question is pending, we get that out</p> <p>15 of the way, get the answer on the record, and then</p> <p>16 you're more than welcome to go. So just let us</p> <p>17 know if that's the case.</p> <p>18 If at any time I am unclear, which</p> <p>19 certainly will happen probably multiple times over</p> <p>20 the course of this day, please let me know. I'm</p> <p>21 happy to clarify anything I say.</p> <p>22 You are obviously an expert in many</p> <p>23 things, and the -- of which I am less familiar.</p> <p>24 So if I am unclear, please let me know, and we</p> <p>25 will try to get on through it.</p>

Laura Webb, Ph.D.

<p style="text-align: right;">Page 14</p> <p>1 What did you do to prepare for your</p> <p>2 deposition?</p> <p>3 A Well, I met with counsel. I reviewed</p> <p>4 the reports, including my own. I reviewed the</p> <p>5 body of literature that I've been looking at.</p> <p>6 Q Okay. Now, when did you meet with</p> <p>7 counsel?</p> <p>8 A Multiple times.</p> <p>9 Q Do you recall the dates?</p> <p>10 A I -- well, yesterday and last Friday as</p> <p>11 well.</p> <p>12 Q Were those meetings here in Burlington,</p> <p>13 Vermont?</p> <p>14 A They were.</p> <p>15 Q How many lawyers were present?</p> <p>16 A Yesterday, two, and last Friday, three.</p> <p>17 Q Do you recall any other meetings?</p> <p>18 A Yes, there were prior meetings. I just</p> <p>19 don't remember the dates offhand.</p> <p>20 Q Okay. Approximately how many prior</p> <p>21 meetings would you say?</p> <p>22 A Two to three.</p> <p>23 Q Okay. Now, during the course of your</p> <p>24 preparation for this deposition, were you shown</p> <p>25 any documents that refreshed your recollection?</p>	<p style="text-align: right;">Page 16</p> <p>1 BY MR. BURNS:</p> <p>2 Q Exhibit 2 is the -- Exhibit 2 is the</p> <p>3 Notice of Oral and Videotaped Deposition of Laura</p> <p>4 Webb, Ph.D. and Duces Tecum.</p> <p>5 And Exhibit 3 is Defendants' Response to</p> <p>6 Plaintiffs' Document Request contained in Notice</p> <p>7 of Oral and Videotaped Deposition of Laura Webb,</p> <p>8 Ph.D. and Duces Tecum.</p> <p>9 There you go, Dr. Webb.</p> <p>10 A (Peruses document.)</p> <p>11 Q Ready, Dr. Webb?</p> <p>12 A Yes.</p> <p>13 Q Okay, great.</p> <p>14 So let's start with Exhibit 2. This is</p> <p>15 the Notice of Oral and Videotaped Deposition of</p> <p>16 Laura Webb, Ph.D. and Duces Tecum. It's dated</p> <p>17 March 14th, 2019.</p> <p>18 Do you recognize this document?</p> <p>19 A I do not, no.</p> <p>20 Q You don't recall seeing it before?</p> <p>21 A (Witness shakes head.)</p> <p>22 Q But you are appearing today to give</p> <p>23 testimony with respect to a report you previously</p> <p>24 issued; is that correct?</p> <p>25 A That's correct.</p>
<p style="text-align: right;">Page 15</p> <p>1 A I was not shown any documents.</p> <p>2 Q Now, Dr. Webb, I'm going to mark this as</p> <p>3 Plaintiffs' Demonstrative No. 1. It's nothing too</p> <p>4 serious, just a little roadmap for us as we go</p> <p>5 through the day today.</p> <p>6 I intend to cover approximately four</p> <p>7 issues with you as we go through today, and we'll</p> <p>8 check them off as we get through them all.</p> <p>9 The first is your response to the notice</p> <p>10 of deposition and subpoena that you received prior</p> <p>11 to the deposition.</p> <p>12 The second involves your qualifications</p> <p>13 which underpin your testimony and report. I want</p> <p>14 to make sure I spell that right.</p> <p>15 The third involves your preparation to</p> <p>16 render your opinions.</p> <p>17 And the fourth is your report and</p> <p>18 opinions.</p> <p>19 So I want to start with actually the</p> <p>20 subpoena. I'm going to hand you a few documents</p> <p>21 that we have premarked. First will be Exhibit 1,</p> <p>22 your report, or what I believe is your report.</p> <p>23 (Webb Exhibit Nos. 1 through 3</p> <p>24 were premarked for</p> <p>25 identification.)</p>	<p style="text-align: right;">Page 17</p> <p>1 Q And is that report reflected in</p> <p>2 Exhibit 1, Expert Report of Laura Webb, Ph.D., for</p> <p>3 General Causation Daubert Hearing?</p> <p>4 A That appears to be the very report, yes.</p> <p>5 Q Okay. Thank you.</p> <p>6 Now, I would like you to look at</p> <p>7 Exhibit 3, Dr. Webb. That's Defendants' Response</p> <p>8 to Plaintiffs' Document Request contained in</p> <p>9 Notice of Oral and Videotaped Deposition of Laura</p> <p>10 Webb, Ph.D. and Duces Tecum.</p> <p>11 Do you see that?</p> <p>12 A Yes.</p> <p>13 Q Okay. Are you familiar with this</p> <p>14 document?</p> <p>15 A No, I'm not.</p> <p>16 Q Okay. You don't recall seeing it</p> <p>17 before?</p> <p>18 A No. I saw the notice of deposition, but</p> <p>19 I have not seen this.</p> <p>20 Q Okay. Before coming to the deposition</p> <p>21 today, did you search your files for any relevant</p> <p>22 documents?</p> <p>23 A Before -- sorry. What time frame are we</p> <p>24 talking about?</p> <p>25 Q Well, let me ask a different question</p>

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<p>1 then.</p> <p>2 Prior to your deposition today, were you</p> <p>3 informed that plaintiffs were seeking documents</p> <p>4 from you at the time of this deposition?</p> <p>5 A I knew there -- I mean, I know there are</p> <p>6 documents requested in the notice of deposition,</p> <p>7 and counsel is responsible or, you know, responded</p> <p>8 to those. But that's --</p> <p>9 Q I see. But did you -- were you</p> <p>10 personally informed that you needed to look for</p> <p>11 documents that were responsive to your requests</p> <p>12 from the plaintiffs prior to your deposition?</p> <p>13 A I -- I provided everything that is in my</p> <p>14 reliance, but in terms of in the last few days</p> <p>15 being charged with searching my -- my records, no.</p> <p>16 Q That's right. And we're really talking</p> <p>17 about that period between March 14th of this year,</p> <p>18 2019, and the present.</p> <p>19 So you don't recall being asked to</p> <p>20 search for additional documents during that</p> <p>21 period?</p> <p>22 A I was asked to make sure that my</p> <p>23 reliance list was complete.</p> <p>24 Q Okay. And do you recall when you were</p> <p>25 so instructed?</p>	<p>1 A Excuse me.</p> <p>2 MS. O'DELL: The 26th -- 25th.</p> <p>3 MR. BURNS: It's the 25th. Okay.</p> <p>4 Oh, you're right. It's the 30th -- or</p> <p>5 29th today. I apologize.</p> <p>6 BY MR. BURNS:</p> <p>7 Q Okay. So you prepared this document on</p> <p>8 Monday, March 25th, and the document contains 11</p> <p>9 supplemental materials that you reviewed; is that</p> <p>10 right?</p> <p>11 A Yes.</p> <p>12 Q Okay. And the first five appear to be</p> <p>13 maps; is that right?</p> <p>14 A Yes.</p> <p>15 Q Okay.</p> <p>16 A Or maps and reports in some cases, yes.</p> <p>17 Q Okay. Can you tell me which ones also</p> <p>18 represent reports?</p> <p>19 A Number 1, 3, and I believe number 5.</p> <p>20 Number 4, I'm not sure about.</p> <p>21 Q And just so I understand, because</p> <p>22 there's a little bit of confusion on our side,</p> <p>23 when you listed these materials, and 1, 3 and 5</p> <p>24 contain reports --</p> <p>25 A Mm-hmm.</p>
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<p>1 A Oh, I believe we talked about that last</p> <p>2 Friday.</p> <p>3 Q Now, again, staying with Exhibit No. 3,</p> <p>4 Dr. Webb, the first -- let's see -- the first 19</p> <p>5 pages contains quite a bit of legal -- legal</p> <p>6 mumbo-jumbo that you're probably not too</p> <p>7 interested in that we may or may not fight about</p> <p>8 down the road with your lawyers.</p> <p>9 But after that, the next page is titled</p> <p>10 Expert Report of Laura Webb, Ph.D. for General</p> <p>11 Causation Daubert Hearing, Supplemental List of</p> <p>12 Materials Reviewed.</p> <p>13 Do you see that?</p> <p>14 A Yes.</p> <p>15 Q Okay. Is this a document you prepared?</p> <p>16 A It is. I provided that list.</p> <p>17 Q Okay. And you provided it to counsel?</p> <p>18 A Yes.</p> <p>19 Q Okay. Do you recall when you prepared</p> <p>20 this list?</p> <p>21 A On Monday.</p> <p>22 Q Okay. That would be Monday, March 15th?</p> <p>23 A This past Monday, the 20 -- whatever.</p> <p>24 Yeah.</p> <p>25 Q Maybe 16th.</p>	<p>1 Q -- is there any way we can figure that</p> <p>2 out from the -- from the -- from your citation?</p> <p>3 The citation appears to contain the title of the</p> <p>4 maps, but does that correspond to the articles as</p> <p>5 well?</p> <p>6 A I mean, these are USGS report --</p> <p>7 reports, open file reports. In some cases they're</p> <p>8 maps in a numbered series. So the general</p> <p>9 citations don't necessarily, yes, reveal that.</p> <p>10 Q Okay. Now, the next item is "Zodac, P.,</p> <p>11 1940, A Talc Quarry Near Chester, Vermont."</p> <p>12 Is that an article that you reviewed?</p> <p>13 A Yes.</p> <p>14 Q And item 7, Deposition of Ann G. Wylie.</p> <p>15 Is that a deposition transcript?</p> <p>16 A Yes.</p> <p>17 Q And next one is Expert Report of Ann G.</p> <p>18 Wylie. Did you have access to the entire report?</p> <p>19 A I did.</p> <p>20 Q And the supporting materials?</p> <p>21 A Can you define "supporting materials"?</p> <p>22 Q Yeah, the documents that would have been</p> <p>23 cited as the list of materials reviewed or relied</p> <p>24 on.</p> <p>25 A I only read the expert report, so I</p>

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<p style="text-align: right;">Page 22</p> <p>1 didn't -- there may have been some common 2 materials cited, but I did not dig into those, so 3 to speak. 4 Q Okay. The next one is Deposition of 5 Mary Poulton, and that's a deposition transcript? 6 A Yes. 7 Q Next is Expert Report of Mary Poulton. 8 Did you read the entire report? 9 A I -- I read good portions of it. I 10 think there were some areas that I skimmed. 11 Q Did you have access to the whole report? 12 A I did, yes. 13 Q And did you review the materials 14 reviewed or relied upon? 15 A No. 16 Q Next one is expert report of Darby Dyar. 17 Did you have access to the full report? 18 A I did, yes. 19 Q And did you review that full report? 20 A I did. Again, portions -- some portions 21 I read in more detail than others, but I did see 22 the full report. 23 Q And did you review the materials 24 reviewed or relied upon? 25 A No.</p>	<p style="text-align: right;">Page 24</p> <p>1 Q 2011. Okay. Now, that isn't listed in 2 your supplement materials, is it? 3 A No. It's cited in my report. 4 Q Okay. And now, if you wouldn't mind 5 proceeding to that second map. 6 A Yes. 7 Q Okay. And how does this correspond, if 8 at all, to your supplemental materials? 9 A It does not. 10 Q Okay. 11 A I mean, I will make -- so the link 12 between the supplemental materials and these maps 13 are the -- the pushpins that mark the locations of 14 certain mines or geologic bodies, for example. So 15 when I first put this together, this is a Google 16 Earth compilation. In terms of locating these 17 bodies, in some cases on this Ratcliffe, et al., 18 2011 map, I also compared with maps, these more 19 detailed quadrangle maps. 20 Q Okay. And when you refer to the more 21 detailed quadrangle maps, you're referring to 22 those that are listed in your supplemental 23 materials? 24 A Yeah. So it was in providing this that 25 I recalled I had looked at these many months ago</p>
<p style="text-align: right;">Page 23</p> <p>1 Q Okay. In Exhibit 3, Dr. Webb, if you go 2 down, if you go to the end of the exhibit, there 3 appear to be five maps or graphical 4 representations that are part of these materials. 5 A Yes. 6 Q Okay. This may be a little difficult, 7 but if we could stay with your supplemental list 8 of materials reviewed. Can you tell me how these 9 maps correspond, if at all, to those supplemental 10 materials? 11 A Well, the -- the geologic map -- 12 Q Now, we're looking there at the map that 13 says "Google Earth Image, U.S. Geographical 14 Survey"? 15 A Yes. So there are basically two map 16 backdrops. There's the one that is much more 17 complicated looking, and that is the Vermont State 18 Bedrock map by Ratcliffe, et al., 2011. 19 Q Is that the first map in the material? 20 A Yes. And then the second one is the 21 metamorphism tile from Doll, et al., 1961. 22 Q And if I can just pause you there. 23 You said the first map was from 24 Ratcliffe, and what was the date on that? 25 A 2011.</p>	<p style="text-align: right;">Page 25</p> <p>1 when I was determining locations, and that's 2 why -- I haven't looked at them recently. This is 3 why they were added as a supplement. 4 Q I see. Okay. So the second map we were 5 looking in -- looking at, another Google Earth 6 map, is this map cited in your report as well? 7 A Yes, it is. It's Doll, et al., 1961. 8 Q Now, let's turn to the third map. A lot 9 going on in this one. 10 A Yes. This is a -- I zoomed in on the 11 Chester dome area. So it's the same background 12 map as the first one. 13 I'm sorry, I cut you off there. 14 Q No, that's fine. 15 Okay. So the third map is a zoomed-in 16 version of the first map focusing on the Chester 17 dome. 18 A That's correct. 19 Q Is that right? 20 A Yes. 21 Q And that is Ratcliffe, 2011? 22 A Yes. 23 Q Now, the fourth map, what are we looking 24 at here? 25 A That's the zoomed-in version of the</p>

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<p style="text-align: right;">Page 26</p> <p>1 Doll, 1961 map. So my -- yeah, generally I was</p> <p>2 trying to show the detail that you can't see in</p> <p>3 the first two.</p> <p>4 Q Okay. And how do you -- is it D-A-L-L?</p> <p>5 A I'm sorry?</p> <p>6 Q Is Doll D-A-L-L?</p> <p>7 A D-O-L-L.</p> <p>8 Q D-O-L-L. Okay.</p> <p>9 All right. And that leaves us with I</p> <p>10 believe one map. The fifth map, what is -- what</p> <p>11 are we looking at here?</p> <p>12 A That's zoomed in further at the northern</p> <p>13 end of the Chester dome.</p> <p>14 Q From the 2011?</p> <p>15 A 2000 -- Ratcliffe, 2011, yes. Sorry,</p> <p>16 Ratcliffe, et al.</p> <p>17 Q Okay. And this is the northern end of</p> <p>18 the Chester dome?</p> <p>19 A Yes.</p> <p>20 Q Okay. Let's start with -- I guess</p> <p>21 really the Ratcliffe map that's reflected in maps</p> <p>22 1, 3, I think, and 5; is that right?</p> <p>23 A Yes.</p> <p>24 Q Okay. When did you prepare this map?</p> <p>25 A Well, I began compiling this information</p>	<p style="text-align: right;">Page 28</p> <p>1 the northern end of the Chester dome. Then --</p> <p>2 sorry, so again some things didn't show up well at</p> <p>3 this -- at this area. So Argonaut would be near</p> <p>4 the Rainbow and Frostbite mines, and then Hamm</p> <p>5 mine is further down.</p> <p>6 Q And these pushpins carry over then to</p> <p>7 your zoomed versions?</p> <p>8 A They do, yes.</p> <p>9 Q Okay. And if you look at that map</p> <p>10 number 3, Argonaut mine, for example, there's</p> <p>11 pushpins somewhere sort of in the upper middle of</p> <p>12 the page; is that right?</p> <p>13 A Yes.</p> <p>14 Q What was your purpose in compiling this</p> <p>15 information and creating this map?</p> <p>16 A Well, it's critical to understand the</p> <p>17 location of the mines with respect to the</p> <p>18 distribution of -- of geologic units, and in</p> <p>19 particular -- of particular interest is also the</p> <p>20 metamorphic grades of these rocks, which is why</p> <p>21 the Doll map is -- is used. Because the geology</p> <p>22 is actually very complex. There's -- I mean,</p> <p>23 three collisional orogenies that -- that give rise</p> <p>24 to the overall structure of -- of geologic units</p> <p>25 here.</p>
<p style="text-align: right;">Page 27</p> <p>1 really when I was first retained by Shook Hardy &</p> <p>2 Bacon.</p> <p>3 Q And was that in 2017?</p> <p>4 A That's correct.</p> <p>5 Q When you say you began compiling this</p> <p>6 information, what do you mean?</p> <p>7 A I mean by determining the exact</p> <p>8 locations of -- of different geologic bodies on</p> <p>9 this backdrop of the -- the bedrock map of Vermont</p> <p>10 and the metamorphism tile.</p> <p>11 Q Can you give us an example in this first</p> <p>12 map, the Ratcliffe, 2011 -- Ratcliffe, et al.,</p> <p>13 2011, of the type of specific information you were</p> <p>14 trying to show on this map?</p> <p>15 A Yeah. So, again, for example, the</p> <p>16 Ludlow area mines, I was trying to determine the</p> <p>17 exact location of -- of those mines with regard to</p> <p>18 the geology.</p> <p>19 Q Okay. And can you tell me where those</p> <p>20 are reflected on this map? I see, on your</p> <p>21 pushpins; is that right?</p> <p>22 A Yes, yes.</p> <p>23 Q Okay.</p> <p>24 A So you see there's -- maybe two-thirds</p> <p>25 down the page almost, the Hammondsville quarry,</p>	<p style="text-align: right;">Page 29</p> <p>1 And so there are pretty dramatic changes</p> <p>2 and grades of metamorphism over short distances,</p> <p>3 and I had to understand exactly where the mines</p> <p>4 were with regard to the metamorphic histories</p> <p>5 recorded by the rock units.</p> <p>6 Q So how would you manipulate these maps</p> <p>7 to assist you in -- in coming to that</p> <p>8 understanding?</p> <p>9 A I wouldn't manipulate them. I would</p> <p>10 just refer to them.</p> <p>11 Q Okay. And perhaps that's the wrong</p> <p>12 term, but I assume you mean -- you're probably not</p> <p>13 looking at map number 1, but you're looking and</p> <p>14 trying to zoom in at times on maps 3 and 5 to get</p> <p>15 a better sense of the surrounding geology. Is</p> <p>16 that fair or --</p> <p>17 A As a geologist, I'm always moving in and</p> <p>18 out of scales, from thinking about the whole state</p> <p>19 of Vermont scale to, again, the micron scale and</p> <p>20 samples. So, yes, moving in and out of zoom</p> <p>21 ranges is part and parcel.</p> <p>22 Q Sure. Is it important then in addition</p> <p>23 to having sort of general maps or larger scale</p> <p>24 maps to have those much more finite and detailed</p> <p>25 maps of particular regions or areas?</p>

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<p style="text-align: right;">Page 30</p> <p>1 MR. FROST: Objection to form.</p> <p>2 THE WITNESS: Yes, I found I was</p> <p>3 referring to those in detail because some</p> <p>4 bodies -- the level of detail shown in maps is a</p> <p>5 function of the scale of the map itself. So the</p> <p>6 1:24,000 quadrangle maps show some finer scale</p> <p>7 details than the Ratcliffe map, but this was the</p> <p>8 best map available, the most up to date, and the</p> <p>9 best one for the -- the compilation of the data.</p> <p>10 BY MR. BURNS:</p> <p>11 Q And when you refer to the compilation of</p> <p>12 the data, do you mean plotting these multiple</p> <p>13 points, multiple mine sites on a single map?</p> <p>14 A I mean, that's part of it again. It's,</p> <p>15 again, understanding the -- the system, the</p> <p>16 geologic system, the distribution of the rocks and</p> <p>17 the rock types and those geologic structures such</p> <p>18 as faults.</p> <p>19 Q But if you were wanting to look at a</p> <p>20 particular -- a particular mine site -- for</p> <p>21 example, let's say the Argonaut mine or the</p> <p>22 Johnson mine -- you wouldn't want to start -- stop</p> <p>23 at map number 1 or even map number 3 or 5.</p> <p>24 Would you want to get as much detail as</p> <p>25 possible and as much of the minute scale as</p>	<p style="text-align: right;">Page 32</p> <p>1 ultimately wanted to opine on whether there was a</p> <p>2 potential for asbestos contamination in talc</p> <p>3 deposits in that mine, is it fair to say that you</p> <p>4 would want to drill down on the most finite or</p> <p>5 specific information, including maps on the</p> <p>6 Argonaut mine, before you made that opinion?</p> <p>7 MR. FROST: Objection to form.</p> <p>8 THE WITNESS: I mean, maps are part of</p> <p>9 it, but I was really looking at a much broader</p> <p>10 range of petrological information.</p> <p>11 BY MR. BURNS:</p> <p>12 Q So is the answer then that you would not</p> <p>13 want that fine level of detail?</p> <p>14 MR. FROST: Objection to form.</p> <p>15 THE WITNESS: I mean, the answer is it</p> <p>16 depends. I mean, we're kind of -- I think I would</p> <p>17 need more specific -- more specific questions in</p> <p>18 order to give you a more specific answer. Sorry.</p> <p>19 BY MR. BURNS:</p> <p>20 Q Well, for example, if there was a</p> <p>21 geologic map of the Argonaut mine available, would</p> <p>22 you want to see that?</p> <p>23 A I guess, yeah, if there was good data</p> <p>24 and -- and context there. But I actually, you</p> <p>25 know, felt that I had the information I -- I</p>
<p style="text-align: right;">Page 31</p> <p>1 possible when you were considering the geology of</p> <p>2 the area?</p> <p>3 MR. FROST: Objection to form.</p> <p>4 THE WITNESS: Yeah, well, I mean it</p> <p>5 depends on where the outstanding questions are,</p> <p>6 where you're driven to, in that sense.</p> <p>7 BY MR. BURNS:</p> <p>8 Q Okay. Well, if the question --</p> <p>9 outstanding questions were, as they are in this</p> <p>10 case, say, proximity of a talc deposit to</p> <p>11 potential asbestos, amphibole or other materials,</p> <p>12 would you want that higher scale, more minute</p> <p>13 scale?</p> <p>14 MR. FROST: Objection to form.</p> <p>15 THE WITNESS: Again, I mean, you know,</p> <p>16 what I'm driven to search for is a product of what</p> <p>17 I'm -- I'm finding, and so -- and also what --</p> <p>18 what actually exists.</p> <p>19 BY MR. BURNS:</p> <p>20 Q Well, and maybe I can be clearer, and I</p> <p>21 apologize if I'm not.</p> <p>22 But as a scientist of your experience,</p> <p>23 and clearly you have published a lot and have</p> <p>24 significant length of time in this field, but if</p> <p>25 you were looking at, say, the Argonaut mine and</p>	<p style="text-align: right;">Page 33</p> <p>1 needed based on the -- the resources that I looked</p> <p>2 at to have what I think is a very good</p> <p>3 understanding of the -- the petrology.</p> <p>4 Q As a scientist, is it fair to say that</p> <p>5 more information is better than less information?</p> <p>6 MR. FROST: Objection to form.</p> <p>7 THE WITNESS: It depends. It depends on</p> <p>8 the quality of the information.</p> <p>9 BY MR. BURNS:</p> <p>10 Q Assuming that the quality is good, is it</p> <p>11 fair to make that assumption?</p> <p>12 MR. FROST: Objection to form.</p> <p>13 THE WITNESS: I guess, yeah, we -- yeah,</p> <p>14 information is good if there's -- if you're able</p> <p>15 to evaluate the -- the real data and the -- the</p> <p>16 methodology.</p> <p>17 BY MR. BURNS:</p> <p>18 Q Would it be important for you to</p> <p>19 actually review data or maps that were prepared</p> <p>20 by, for instance, a company actually operating the</p> <p>21 mine and having day-to-day experience with the</p> <p>22 extraction of minerals?</p> <p>23 MR. FROST: Objection to form.</p> <p>24 THE WITNESS: It depends what's -- you</p> <p>25 know, what's shown on those maps, I suppose, in</p>

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<p>1 terms of detail.</p> <p>2 BY MR. BURNS:</p> <p>3 Q I'm sorry. Did you --</p> <p>4 A Yeah, I mean, I was going to say,</p> <p>5 again -- I mean, I really feel like I arrived</p> <p>6 at -- with -- at a place where I had the</p> <p>7 information I needed to basically meet -- meet my</p> <p>8 charge.</p> <p>9 Because, again, I mean, what you see in</p> <p>10 the rocks is -- is not -- is not random. What we</p> <p>11 see is very specifically controlled by the bolt</p> <p>12 composition of the rocks, the pressure and</p> <p>13 temperature conditions under which they were</p> <p>14 metamorphosed, the fluids that were present,</p> <p>15 and -- so I really -- you know, a good deal of my</p> <p>16 effort was really trying to understand, again, the</p> <p>17 petrologic systems of -- of these rocks -- sorry,</p> <p>18 these mines -- in detail.</p> <p>19 And so, you know, that information</p> <p>20 was -- was pretty clear from what I was able to</p> <p>21 review in the literature.</p> <p>22 Q Well, and just to be clear here, you're</p> <p>23 speaking, I take it, of your opinion generally as</p> <p>24 to the propensity for some of these formations to</p> <p>25 result in asbestos contamination of talc; is that</p>	<p>1 And really it's about sort of the --</p> <p>2 understanding the location of these is what helped</p> <p>3 me basically place these rocks in the context of</p> <p>4 the -- the evolution of this region.</p> <p>5 So again, yes, this was a starting point</p> <p>6 for, again, sort of other literature searches</p> <p>7 and -- and determining the -- the types of other</p> <p>8 information I needed to compile.</p> <p>9 Q But just so I'm clear at this early</p> <p>10 stage in the deposition as to your opinion, is it</p> <p>11 your opinion that there is no asbestos</p> <p>12 contamination in the J&J mines in Vermont?</p> <p>13 A I see no --</p> <p>14 MR. FROST: Objection to form.</p> <p>15 THE WITNESS: I see no evidence to</p> <p>16 support the claim that there is asbestos in these</p> <p>17 mines.</p> <p>18 BY MR. BURNS:</p> <p>19 Q Among the materials that you've</p> <p>20 reviewed?</p> <p>21 MR. FROST: Objection.</p> <p>22 THE WITNESS: Well, I mean, my opinion</p> <p>23 is my opinion, which is based on the review of --</p> <p>24 of multiple papers, maps, and reports, and so, you</p> <p>25 know, I didn't really adopt something that was</p>
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<p>1 right?</p> <p>2 A Yes.</p> <p>3 MR. FROST: Objection to form.</p> <p>4 BY MR. BURNS:</p> <p>5 Q And that is a general opinion, not a</p> <p>6 specific opinion. Is that right?</p> <p>7 MR. FROST: Objection.</p> <p>8 THE WITNESS: That's pretty specific to</p> <p>9 these -- to these mines.</p> <p>10 BY MR. BURNS:</p> <p>11 Q Well, so, for instance, did you use maps</p> <p>12 1, 3 and 5 to reach the opinion that there was no</p> <p>13 asbestos contamination in the talc that was mined</p> <p>14 in what I will refer to as the J&J mines? I think</p> <p>15 you may use that term in your report as well.</p> <p>16 A Yeah. Well, this was a starting point.</p> <p>17 Q Yeah. What do you mean by "a starting</p> <p>18 point"?</p> <p>19 A In other words, I had to know where the</p> <p>20 mines were with respect to the geology of Vermont,</p> <p>21 with respect to the structure. That is, again,</p> <p>22 the result of multiple orogenic events that</p> <p>23 basically have folded and stretched these rock</p> <p>24 units that have a major impact, again, on the</p> <p>25 distribution of different metamorphic grades.</p>	<p>1 stated in the literature. I -- I synthesized all</p> <p>2 that information to arrive at the opinions I</p> <p>3 presented in this report.</p> <p>4 BY MR. BURNS:</p> <p>5 Q No, and -- and we'll get back to that,</p> <p>6 and I didn't mean to insinuate otherwise, Doctor.</p> <p>7 My point was really simply that your</p> <p>8 opinion is based on the materials you've listed in</p> <p>9 your report; is that right?</p> <p>10 MR. FROST: Objection to form.</p> <p>11 THE WITNESS: Yes, I've provided the</p> <p>12 reliance, and that is what I reviewed to arrive at</p> <p>13 my opinions, yes.</p> <p>14 BY MR. BURNS:</p> <p>15 Q Okay. And so if it's not listed in the</p> <p>16 materials that you relied on, then it's safe to</p> <p>17 assume that it is not something that you utilized</p> <p>18 to reach your opinion.</p> <p>19 A I'm sorry, I couldn't hear --</p> <p>20 Q Certainly.</p> <p>21 A -- the last part of your question.</p> <p>22 Q Yeah, no problem. I -- I'll restate it.</p> <p>23 So if -- if a material is not listed in</p> <p>24 the materials upon which you relied in your report</p> <p>25 or the supplemental listing that your counsel</p>

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<p style="text-align: right;">Page 38</p> <p>1 provided last night, then it's safe to assume that</p> <p>2 you didn't rely on missing material to reach your</p> <p>3 opinions.</p> <p>4 MR. FROST: Objection to form.</p> <p>5 THE WITNESS: I'm not sure what you mean</p> <p>6 by relying on missing material. So --</p> <p>7 BY MR. BURNS:</p> <p>8 Q I'll switch it around. Is there</p> <p>9 anything besides those materials that you have</p> <p>10 listed in your report or in the supplemental list</p> <p>11 that we received last night on which you've relied</p> <p>12 in reaching your opinions?</p> <p>13 A No. To the best of my knowledge, I've</p> <p>14 given you a complete list. Beyond, again, sort of</p> <p>15 the -- my general experience and educational</p> <p>16 background. Certainly that plays in.</p> <p>17 Q Sure. So you began compiling the maps</p> <p>18 that are reflected in 1, 3 and 5 in Exhibit 3 as</p> <p>19 far back as 2017.</p> <p>20 When -- when had you completed the</p> <p>21 compilation of information that's reflected in</p> <p>22 these maps 1, 3 and 5?</p> <p>23 A Is this the first one?</p> <p>24 I'm sorry, I'm just looking in detail at</p> <p>25 what's listed --</p>	<p style="text-align: right;">Page 40</p> <p>1 Others, I -- I confirmed by -- you know,</p> <p>2 I did some actual just general web searches. And</p> <p>3 so, for example, I think some of the -- the mine</p> <p>4 locations are based on having seen town meeting</p> <p>5 documents where they talked about wastewater</p> <p>6 permits and gave the actual road that the map was</p> <p>7 located on. So it was kind of a variety of ways.</p> <p>8 Q I see. Were there any other sources</p> <p>9 that you used to create those pinpoints that you</p> <p>10 can recall?</p> <p>11 A No. I mean, nothing noteworthy. Again,</p> <p>12 I mean, based on, you know, literature references</p> <p>13 and then trying to confirm the most precise</p> <p>14 location, like I said, with some of those permits</p> <p>15 that I saw.</p> <p>16 Q Okay.</p> <p>17 A So...</p> <p>18 Q Now, throughout the day we're probably</p> <p>19 going to use the term "J&J mines" just for ease of</p> <p>20 reference in Vermont and elsewhere, and, you know,</p> <p>21 between China and Italy, I can easily distinguish</p> <p>22 those.</p> <p>23 But what's your understanding of the J&J</p> <p>24 mines in Vermont that were used to source talc for</p> <p>25 Johnson & Johnson Baby Powder or Shower to Shower</p>
<p style="text-align: right;">Page 39</p> <p>1 Q No problem.</p> <p>2 A -- on here and trying to think if there</p> <p>3 was anything added in the last year, but I would</p> <p>4 say this has -- this has existed for a year or so.</p> <p>5 The exact dates I don't remember.</p> <p>6 Q And that's true of the zoomed-in</p> <p>7 portions as well?</p> <p>8 A Again, this is from a Google Earth</p> <p>9 database, so you zoom in and zoom out in real</p> <p>10 time. So...</p> <p>11 Q The compilation of material doesn't</p> <p>12 change.</p> <p>13 A Right, that's correct.</p> <p>14 Q Okay. Now, how did you establish the</p> <p>15 location of the pushpins on the maps?</p> <p>16 A Oh, there were a variety of methods. In</p> <p>17 some cases locations were taken from the published</p> <p>18 literature. And that could come in a variety of</p> <p>19 ways, from actual GPS coordinates listed to</p> <p>20 descriptions.</p> <p>21 So, for example, the Newfane mine is</p> <p>22 something that was basically a -- a description in</p> <p>23 a paper that then I conferred with the detailed</p> <p>24 quadrangle map to find the location, and then</p> <p>25 added the pushpin to this larger scale map.</p>	<p style="text-align: right;">Page 41</p> <p>1 products?</p> <p>2 MR. FROST: Well, I will just lodge a</p> <p>3 general objection to referring to the mines as</p> <p>4 "J&J mines." If it's fine with you, we can call</p> <p>5 it a standing objection so I don't have to object</p> <p>6 every time you say it.</p> <p>7 MR. BURNS: That's fine, yeah.</p> <p>8 And just to cover your concern, I'm not</p> <p>9 imputing in any way that they were owned by J&J or</p> <p>10 controlled.</p> <p>11 MR. FROST: Okay.</p> <p>12 MR. BURNS: That's a different issue.</p> <p>13 BY MR. BURNS:</p> <p>14 Q But really the source for baby powder</p> <p>15 used in -- or talc used in baby powder or</p> <p>16 shower -- Shower to Shower products. Sorry.</p> <p>17 A Yes.</p> <p>18 MS. O'DELL: Excuse me. You aren't</p> <p>19 saying they weren't -- aren't presently, but they</p> <p>20 could be known to produce.</p> <p>21 MR. BURNS: Right. Right. Fair enough.</p> <p>22 MR. FROST: Yep, that's fine. Just, you</p> <p>23 know, I'll lodge my general objection, but I --</p> <p>24 MR. BURNS: Understood.</p> <p>25 MR. FROST: -- for ease of reference,</p>

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<p style="text-align: right;">Page 42</p> <p>1 that's -- that's fine, pending my objection.</p> <p>2 THE WITNESS: So my understanding is</p> <p>3 that the talc for talcum powders came from the</p> <p>4 Hammondsville, Argonaut and Hamm mines.</p> <p>5 BY MR. BURNS:</p> <p>6 Q And that's a complete list?</p> <p>7 A As far as I --</p> <p>8 Q That you understood --</p> <p>9 A Yeah, for -- for Vermont, yes.</p> <p>10 Q Now, you've included in your maps</p> <p>11 pushpins for several other mines in the area. Why</p> <p>12 did you do that?</p> <p>13 A So, for example, the Frostbite mine, I</p> <p>14 refer to a study by Robinson -- I believe that's</p> <p>15 the name -- Robinson, et al., 2006. So they</p> <p>16 looked at the Frostbite mine.</p> <p>17 The Grafton mine was in the Sanford,</p> <p>18 1982, paper that I cite. Newfane as well.</p> <p>19 So in some cases, you know, these are</p> <p>20 mines where there were detailed studies done that</p> <p>21 are relevant to what I was trying to accomplish</p> <p>22 in -- in terms of my understanding of the</p> <p>23 petrology.</p> <p>24 Q Okay. Now, can you -- I'm looking at</p> <p>25 map number 1 and do not see the Argonaut mine</p>	<p style="text-align: right;">Page 44</p> <p>1 Q Now, you've referenced the Chester dome,</p> <p>2 which appears kind of on the right-hand side of</p> <p>3 the -- of many of these maps.</p> <p>4 What is the significance of the Chester</p> <p>5 dome?</p> <p>6 A So, again, that's the main geologic</p> <p>7 structure. I mean, I think it shows up probably</p> <p>8 perhaps best on the Doll, et al., 1961, map here</p> <p>9 in terms of that elongate north-south blob.</p> <p>10 But again, this is a dome that has a --</p> <p>11 a sordid tectonic past. So the structure of the</p> <p>12 dome is, again, the result of the tectonic Acadian</p> <p>13 and the Alleghanian orogenies, and the -- the</p> <p>14 metamorphism that's recorded by these rocks around</p> <p>15 the dome is -- is -- basically it's dominated by</p> <p>16 the -- the Acadian orogeny, and this is the time</p> <p>17 at which the talc forms, during that tectonic</p> <p>18 event.</p> <p>19 But subsequently, the rocks have been</p> <p>20 folded, so you have actually the deepest -- so the</p> <p>21 rocks in the core of the dome record the highest</p> <p>22 pressures and the highest temperatures, upper</p> <p>23 amphibolite up to granulite facies. So that has a</p> <p>24 direct control on the types of minerals that you</p> <p>25 would see, for example, in the Grafton and the</p>
<p style="text-align: right;">Page 43</p> <p>1 referenced there. Is that a function of the</p> <p>2 scale?</p> <p>3 A It is. And that's why part of the</p> <p>4 motivation for blowing up certain regions for</p> <p>5 detail, yeah, because those names would have</p> <p>6 overlapped in the first, yes.</p> <p>7 Q I see. It is reflected in number 3.</p> <p>8 A Yes.</p> <p>9 Q The third map.</p> <p>10 A Yes.</p> <p>11 Q Now, how -- now, Ratcliffe, 2011, was</p> <p>12 cited in your original report. How, if at all,</p> <p>13 did these maps 1, 3 and 5 inform your opinions in</p> <p>14 your report?</p> <p>15 A Well, again, it's the understanding of</p> <p>16 where the mines are located relevant to the</p> <p>17 geologic structure of the Chester dome, which</p> <p>18 relates directly to the grades of metamorphism of</p> <p>19 the rocks that are exposed on the surface around</p> <p>20 the dome.</p> <p>21 And so, again, this was kind of a</p> <p>22 starting point in terms of location and units and</p> <p>23 structure that then feeds into the petrological</p> <p>24 analysis as a function of -- of metamorphic grade</p> <p>25 and history.</p>	<p style="text-align: right;">Page 45</p> <p>1 Chester Carlton quarries.</p> <p>2 And as you move, in this case, west or</p> <p>3 north, you move to lower grades of metamorphism.</p> <p>4 So, you know, the Hammondsville quarry is at a</p> <p>5 lower metamorphic grade relative to the Grafton or</p> <p>6 Chester Carlton quarries. The Argonaut and</p> <p>7 Newfane mines, they're again sort of pre- --</p> <p>8 virtually similar to the Hammondsville.</p> <p>9 So, again, you know, basically you've</p> <p>10 got this high temperature, higher pressure suite</p> <p>11 of rocks in the core of the dome and lower grade</p> <p>12 rocks mantling it.</p> <p>13 Q And when you refer to lower grades of</p> <p>14 metamorphism, can you explain that?</p> <p>15 A So, for example, in my report, I think</p> <p>16 it's Figure 6, I've got a diagram with pressure</p> <p>17 and temperature and different -- what geologists</p> <p>18 call metamorphic facies. These are regions and</p> <p>19 pressure temperature space where we expect rocks</p> <p>20 of similar bulk composition to show similar</p> <p>21 metamorphic assemblages as a function of those PT</p> <p>22 conditions.</p> <p>23 And so while rocks, say, at Grafton were</p> <p>24 metamorphosed around 700 or 750 degrees C,</p> <p>25 Hammondsville, Argonaut -- sorry, centigrade --</p>

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<p style="text-align: right;">Page 46</p> <p>1 Hammondsville and the Argonaut, Hamm, Newfane, 2 those were all at what we would say Greenschist 3 facies conditions, which is roughly in the range 4 of 550 to -- or -- well, to lower amphibolite, so 5 550 to 575 degrees C. 6 Q Okay. To shorthand that, and tell me if 7 I'm right or wrong -- and I appreciate your 8 answer -- compared to the Chester dome then, would 9 you say that the rocks in the J&J mines were 10 formed in lower temperatures and lower pressure? 11 A Yes, compared to the core of the Chester 12 dome. So the center of that -- that elongate 13 body, lower temperatures of metamorphism and -- 14 and still relatively high pressures but lower 15 pressures as well. 16 Q And I heard you use the term "TP." Is 17 that temperature and pressure? 18 A PT, yeah. 19 Q Or PT, pressure and temperature. 20 A Yes, that's correct. 21 Q Okay. And it is PT, not TP? 22 A Maybe we say PT because TP sounds too 23 much like toilet paper. 24 Q That's a fair point. 25 A But, you know, they're just</p>	<p style="text-align: right;">Page 48</p> <p>1 that in the report, and I refer to Doll, et al., 2 1961, as well as Karabinos, 2010. 3 Q Now, the Doll maps here, tell me about 4 your process for preparing these maps. How did 5 you do it? 6 A Well, the Doll map preexisted me, my 7 birth, by ten years, but -- excuse me -- basically 8 by, you know, georeferencing the -- the map. So 9 you can line up the boundary of the state of 10 Vermont in the map with the boundary of the state 11 of Vermont that you see in -- in Google Earth. 12 And similar to the -- the bedrock map of Vermont. 13 So I basically had different layers on the Google 14 Earth map backdrop. 15 Q And what was your purpose for doing that 16 with the Doll maps? 17 A Well, it's, again, the same thing in 18 terms of seeing where the mines plot relative to 19 grades of metamorphism that are presented in -- in 20 this map. 21 I mean, I guess I would say that -- 22 yeah, I mean, the purpose for choosing this map, 23 again, because it showed the -- the whole state. 24 The areas around the Chester dome have been 25 refined slightly by Karabinos, et al., 2010.</p>
<p style="text-align: right;">Page 47</p> <p>1 abbreviations, shorthand, yeah. 2 Q Let's look at the Doll maps then, 2 and 3 4. 4 Well, actually, just briefly before I 5 leave the Ratcliffe, 2011, these were produced 6 last night. Have these -- has the -- have the -- 7 let me strike that. 8 Do the inclusion of these maps in your 9 supplemental materials provided last night 10 indicate in any way that they have altered or 11 changed the opinions in your report? 12 MR. FROST: Objection to form. 13 THE WITNESS: No. Again, these were 14 created prior to the submission of my report, and 15 in fact -- I mean, basically these -- there's a 16 version of this map as a figure in my report that 17 shows locations. So... 18 BY MR. BURNS: 19 Q And is that true of the Doll maps as 20 well? 21 A Yeah, nothing has changed with respect 22 to the Doll maps. I -- I refer to the Doll maps 23 and the isograds, which again relates to the -- 24 isograd means, on a map, a contour of equal grade 25 of metamorphism. So I refer to -- I speak about</p>	<p style="text-align: right;">Page 49</p> <p>1 Q Now, when did you prepare this map or 2 this overlay? 3 A As I said, I mean, I've had it for at 4 least a year on my computer. So -- again, this 5 was really the starting point of my -- my work on 6 this issue. 7 Q Okay. Now, map 4 is a zoom of map 8 number 2, correct, showing more clearly the 9 Chester dome? 10 A Yes. 11 Q And it also shows the Argonaut, Hamm, 12 and Hammondsville mines; is that right? 13 A Yes. 14 Q Okay. Among others. 15 A Yeah. 16 Q Okay. I'll drop that pen about 20 times 17 today, so don't worry. 18 MR. BURNS: All right. How about we 19 take a short break, and when we come back, we'll 20 go through the other maps we got this morning. 21 MR. FROST: Okay. 22 THE VIDEOGRAPHER: Going off -- going 23 off the record at 10:27. 24 (Recess.) 25 THE VIDEOGRAPHER: We're back on the</p>

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<p>1 record at 10:46 a.m.</p> <p>2 BY MR. BURNS:</p> <p>3 Q Welcome back, Dr. Webb.</p> <p>4 I'd ask you to turn to your list of</p> <p>5 supplemental materials in Exhibit 3 again. It's</p> <p>6 about 20 pages deep.</p> <p>7 A Okay.</p> <p>8 Q All right. And before we get there, I</p> <p>9 was discussing with your counsel, and I understand</p> <p>10 that the maps we had been discussing, the five</p> <p>11 maps in Exhibit 3, those were contained in your</p> <p>12 files; is that right?</p> <p>13 A Yeah. I guess I'm confused by the</p> <p>14 terminology --</p> <p>15 Q That's fine.</p> <p>16 A -- of -- so --</p> <p>17 Q I understood that. I just want to make</p> <p>18 it clear and hopefully --</p> <p>19 A Yeah.</p> <p>20 Q -- save us some time. Those were maps</p> <p>21 that you had developed and created, and -- and</p> <p>22 presumably were saved on your computer; is that</p> <p>23 fair?</p> <p>24 A Yes. Yes.</p> <p>25 Q Okay. And you provided those after</p>	<p>1 was a long time ago.</p> <p>2 Q Now, did you -- did you read the actual</p> <p>3 report?</p> <p>4 A I went through sections of it.</p> <p>5 Q Okay. Do you recall when you did that?</p> <p>6 A It -- again, it would have been at the</p> <p>7 time that I was putting together that Google Earth</p> <p>8 project. So...</p> <p>9 Q Okay. Can you describe for the Court</p> <p>10 how, if at all, your review of this 1996 Ratcliffe</p> <p>11 article informed your opinions that you're</p> <p>12 offering in this case.</p> <p>13 A Oh, like I said, basically the primary</p> <p>14 purpose -- or one of the primary purposes for</p> <p>15 looking at these was, again, to aid my ability to</p> <p>16 put those pushpins in in the map. But especially</p> <p>17 when there were -- I did look through the map</p> <p>18 indexes, the descriptions of units, and also if</p> <p>19 there were written reports, I looked through those</p> <p>20 to see if there were incidences of reported</p> <p>21 asbestos and, you know.</p> <p>22 Q Do you recall anything specific about</p> <p>23 this 1996 article that informed your opinions?</p> <p>24 A No.</p> <p>25 Q Now, Dr. Webb, we are going to hand</p>
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<p>1 being requested to search your files by counsel?</p> <p>2 A Yes. I think I understand the wording</p> <p>3 now, yeah.</p> <p>4 Q All right. Going back to that</p> <p>5 supplemental list of materials reviewed, I want to</p> <p>6 go through in detail each of the first five</p> <p>7 entries. Starting with Ratcliffe, N.M.,</p> <p>8 parentheses, 1996, Preliminary Bedrock Geologic</p> <p>9 Map of the Andover quadrangle, Windsor County,</p> <p>10 Vermont, U.S. Geological Survey open file report,</p> <p>11 parentheses, No. 96-32, scale 1:24,000.</p> <p>12 Now, in addition to identifying what</p> <p>13 will end up being a series of maps, this entry</p> <p>14 also reflects an article; is that right?</p> <p>15 A Yes, there was a written report that</p> <p>16 accompanied this.</p> <p>17 Q Okay. And when did you review this</p> <p>18 report?</p> <p>19 A Again, probably around a year ago or so.</p> <p>20 I -- again, I added these to -- to the reliance</p> <p>21 list in response to having generated the files</p> <p>22 that we were looking at, the -- the Google Earth</p> <p>23 images. So I recalled that I had a folder of maps</p> <p>24 that -- that were used when I was generating the</p> <p>25 pushpins, et cetera, on that -- on that. So it</p>	<p>1 you -- and this may be a little bulky, I</p> <p>2 apologize -- Exhibits 4A, B and C.</p> <p>3 MR. FROST: I was going to say is there</p> <p>4 a better way -- a better place to put these?</p> <p>5 Probably not.</p> <p>6 MR. BURNS: We can put them back after</p> <p>7 she identifies them.</p> <p>8 MR. FROST: Yeah, I was going to say --</p> <p>9 I just want to make sure we have enough room to</p> <p>10 even, like, plop them down here. Move my stuff</p> <p>11 over.</p> <p>12 (Webb Exhibit Nos. 4A, 4B and 4C</p> <p>13 were marked for identification.)</p> <p>14 BY MR. BURNS:</p> <p>15 Q All right. Thank you.</p> <p>16 So Exhibits 4A, B and C, do those</p> <p>17 correspond to U.S. Geological Survey maps that are</p> <p>18 associated with the Ratcliffe '96 report?</p> <p>19 A Yes, these are three plates as part of</p> <p>20 that report.</p> <p>21 Q I see. And I think I understand based</p> <p>22 on your testimony, but can you tell us again how,</p> <p>23 if at all, you utilized these maps in reaching</p> <p>24 your opinions or in your work?</p> <p>25 A Yeah, so again -- well, I would just say</p>

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<p style="text-align: right;">Page 54</p> <p>1 with respect to this map, I think I used -- this</p> <p>2 preliminary bedrock geologic map of the Andover</p> <p>3 quadrangle had the written report associated with</p> <p>4 it.</p> <p>5 And then the number 2 on that reliance</p> <p>6 list is the digital bedrock map, so that actually</p> <p>7 had the colored map. So I think I -- I referred</p> <p>8 to the color version of the map because the</p> <p>9 details jump out better at you, and then -- and</p> <p>10 then looked at that in comparison to the -- the</p> <p>11 written report.</p> <p>12 I mean, I'll be honest again, it's been</p> <p>13 a while since I've looked at these, so I kind of</p> <p>14 have to lay them down next to each other to figure</p> <p>15 out their spatial relationships in terms of, you</p> <p>16 know -- again, they would basically add up to what</p> <p>17 we see in that Ratcliffe, et al., bedrock map.</p> <p>18 Q And that was maps 1, 3 and 5 of the</p> <p>19 supplemental materials?</p> <p>20 A Yes.</p> <p>21 Q Okay. Thank you.</p> <p>22 And so did you obtain these maps at</p> <p>23 about the same time you obtained the Ratcliffe</p> <p>24 1996 report?</p> <p>25 A These are -- yes. I mean, these maps</p>	<p style="text-align: right;">Page 56</p> <p>1 A It would be about the same time</p> <p>2 basically.</p> <p>3 Q And --</p> <p>4 MR. FROST: Excuse me.</p> <p>5 MR. BURNS: Bless you.</p> <p>6 BY MR. BURNS:</p> <p>7 Q Can you tell us whether these maps in</p> <p>8 any way impacted your opinions that you rendered</p> <p>9 in this case?</p> <p>10 A Well -- again, I mean, using them for</p> <p>11 finding locations, so it was -- it was a starting</p> <p>12 point. I would say also in terms of the review of</p> <p>13 the -- the map unit descriptions and -- and the</p> <p>14 reports, the -- the lack of any report of -- of</p> <p>15 asbestos in -- in them, yes, was, in part,</p> <p>16 contributed to my opinion.</p> <p>17 Q When -- when you said "the lack of any</p> <p>18 report of asbestos in them," were you referring to</p> <p>19 the elements on the map?</p> <p>20 A I mean in total, in terms of seeing</p> <p>21 if -- if there's reference to -- yes, asbestos of</p> <p>22 any type in terms of the description of the units</p> <p>23 in the -- the map area, but also in terms of -- of</p> <p>24 the descriptions in -- in the written report.</p> <p>25 Q Now, Dr. Webb, just so I'm not</p>
<p style="text-align: right;">Page 55</p> <p>1 are part of -- if you go to the USGS site for</p> <p>2 that -- that report, you have access to the -- the</p> <p>3 written report and these plates all together.</p> <p>4 Q I see. And so you obtained them at the</p> <p>5 same time?</p> <p>6 A Yes.</p> <p>7 Q Okay.</p> <p>8 MR. BURNS: Why don't we hand her</p> <p>9 Exhibit No. 2, and then we'll take them all away.</p> <p>10 Or, sorry, Exhibit No. 5A and B, if I remember</p> <p>11 correctly.</p> <p>12 (Webb Exhibit No. 5A and 5B were</p> <p>13 marked for identification.)</p> <p>14 THE WITNESS: Okay.</p> <p>15 BY MR. BURNS:</p> <p>16 Q And, Dr. Webb, do these maps correspond</p> <p>17 to the second entry on your supplemental list of</p> <p>18 materials, Ratcliffe, N.M., 1996, digital bedrock</p> <p>19 geologic map of the Andover quadrangle, Vermont?</p> <p>20 A Yes, they do.</p> <p>21 Q And were these the maps you were just</p> <p>22 referencing and using the colored versions?</p> <p>23 A Yes.</p> <p>24 Q Okay. And when did you obtain these</p> <p>25 maps?</p>	<p style="text-align: right;">Page 57</p> <p>1 testifying for you, when you were referring to</p> <p>2 that area on the right-hand side of the map,</p> <p>3 what -- what is represented there?</p> <p>4 Sorry, the right-hand side.</p> <p>5 A Oh, sorry. This is the description of</p> <p>6 map units. So for each different colored map unit</p> <p>7 on here, there is a -- an age assignment, as it's</p> <p>8 understood, and a basic description of the rock</p> <p>9 type.</p> <p>10 Q Okay. When you say "a basic description</p> <p>11 of the rock type," what do you mean?</p> <p>12 A So right up at the top, it says, you</p> <p>13 know, for example, a map unit that's sort of</p> <p>14 purple, it says "DG," which stands for Devonian</p> <p>15 dikes, and the description is by type, "muscovite,</p> <p>16 granite." So short descriptions of both minerals</p> <p>17 and/or rock names that are standard.</p> <p>18 Q Within that unit?</p> <p>19 A Within that unit and within, yeah, the</p> <p>20 map area.</p> <p>21 Q Within the map. Okay.</p> <p>22 And you said there was an age identifier</p> <p>23 as well?</p> <p>24 A Yes.</p> <p>25 Q Okay. How are those age identifiers and</p>

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<p style="text-align: right;">Page 58</p> <p>1 the rock or mineral identifiers developed? Who</p> <p>2 does that?</p> <p>3 A It's the result of over a hundred years</p> <p>4 of work of geologists out in this region, so --</p> <p>5 and USGS scientists, Vermont state geologists,</p> <p>6 academics who are -- and students who are involved</p> <p>7 in -- in mapping. So it's -- it's really a body</p> <p>8 of information that is refined over decades and</p> <p>9 decades of observation and analysis.</p> <p>10 Q I see. Now, when you said you would</p> <p>11 look at the map units to -- and I'm not trying to</p> <p>12 put words in your mouth, but --</p> <p>13 A Mm-hmm.</p> <p>14 Q -- you said you would look to the map</p> <p>15 units to determine whether asbestos was</p> <p>16 identified. Is that right?</p> <p>17 A Yeah. I mean, I was interested to see</p> <p>18 if it was mentioned anywhere, and then I would</p> <p>19 follow that -- that lead, but --</p> <p>20 Q And what type or what designated map</p> <p>21 units would you be looking for to determine</p> <p>22 whether asbestos was identified?</p> <p>23 A Well, it could be anything if it were</p> <p>24 there, but, I mean, of -- you know, of specific</p> <p>25 focus in this area of Vermont, of course, it's</p>	<p style="text-align: right;">Page 60</p> <p>1 THE WITNESS: They're the ultramafic</p> <p>2 units that are -- that are the protoliths for</p> <p>3 the -- the talc, ores in this case.</p> <p>4 BY MR. BURNS:</p> <p>5 Q How would they -- what's the association</p> <p>6 with asbestos in that context?</p> <p>7 A Well, where asbestos is documented in</p> <p>8 Vermont, it's associated with some ultramafic rock</p> <p>9 units. More typically, I mean, the serpentinite</p> <p>10 and talc and talc schist here, these are basically</p> <p>11 the serpentinite formed during the tectonic</p> <p>12 orogeny, the talc during the Acadian orogeny.</p> <p>13 The ultramafic rocks predated that. And</p> <p>14 where the ultramafic rocks are larger bodies that</p> <p>15 haven't been fully metamorphosed and</p> <p>16 recrystallized during these subsequent orogenic</p> <p>17 events, those are the rocks that -- that are</p> <p>18 reported to occasionally have those asbestos</p> <p>19 veins.</p> <p>20 Q Okay. Now, when you use the term</p> <p>21 "asbestos," how would you define that term?</p> <p>22 A I'm using that to refer to the six</p> <p>23 regulated minerals: So chrysotile, the</p> <p>24 asbestiform varieties of anthophyllite,</p> <p>25 actinolite, tremolite, grunerite and riebeckite.</p>
<p style="text-align: right;">Page 59</p> <p>1 the -- it's the ultramafic units.</p> <p>2 Q Okay. And who are those?</p> <p>3 A What kind of -- sorry, what kind of</p> <p>4 information do you mean or are looking for?</p> <p>5 Q Ultramafic units, what do you mean by</p> <p>6 that term?</p> <p>7 A Uh, right. So these are rocks that are</p> <p>8 basically derived from Earth's mantle. They're</p> <p>9 very rich in magnesium typically.</p> <p>10 Q And what are the -- can you give us some</p> <p>11 examples of those asbestos-bearing rocks?</p> <p>12 MR. FROST: Objection to form.</p> <p>13 THE WITNESS: I can give you an example</p> <p>14 of the ultramafic rocks --</p> <p>15 BY MR. BURNS:</p> <p>16 Q Yes.</p> <p>17 A -- that we were interested in about that</p> <p>18 question.</p> <p>19 But -- so, for example, here it says,</p> <p>20 "Ordovician to late Proterozoic ultramafic rocks.</p> <p>21 Map units OZU and OZT, serpentinite and talc, and</p> <p>22 also talc schist."</p> <p>23 Q And those are the types of ultramafic</p> <p>24 units that might contain asbestos?</p> <p>25 MR. FROST: Objection to form.</p>	<p style="text-align: right;">Page 61</p> <p>1 Q And you did say tremolite, right?</p> <p>2 A Yes.</p> <p>3 Q Okay. Have you reached any opinions in</p> <p>4 your report with respect to whether chrysotile</p> <p>5 asbestos may be found in the J&J mines?</p> <p>6 A I have not seen any indications of that.</p> <p>7 And again, the chrysotile that is reported in --</p> <p>8 in Vermont, it formed during the tectonic orogeny,</p> <p>9 generally at relatively low grades of metamorphism</p> <p>10 in conjunction with like fracturing and fluid</p> <p>11 infiltration of the rocks.</p> <p>12 So, if it were present in the J&J mines,</p> <p>13 as we're referring to them, those units underwent</p> <p>14 very extreme metamorphism, deformation and</p> <p>15 recrystallization during the Acadian orogeny.</p> <p>16 So, again, I haven't seen any chrysotile</p> <p>17 reported in -- in the area in that general belt of</p> <p>18 ultramafic rocks that we're concerned with, and if</p> <p>19 it had been present, I wouldn't expect it to</p> <p>20 survive the -- the Acadian metamorphic event.</p> <p>21 Q And when you -- just to be clear, when</p> <p>22 you say you haven't seen any indication of the</p> <p>23 chrysotile, I assume you're referring to -- you</p> <p>24 are referring to in the list of materials you've</p> <p>25 reported in your report; is that correct?</p>

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<p style="text-align: right;">Page 62</p> <p>1 MR. FROST: Objection to form.</p> <p>2 THE WITNESS: Yeah, I -- yeah. So, I</p> <p>3 mean, I -- in the documents reviewed. In the</p> <p>4 studies that I -- I looked at, no.</p> <p>5 BY MR. BURNS:</p> <p>6 Q All right. I think we can take these</p> <p>7 away.</p> <p>8 A Thank you.</p> <p>9 Q Now, I'm going to hand you a few</p> <p>10 documents under Exhibit 6.</p> <p>11 (Webb Exhibit No. 6 was marked for</p> <p>12 identification.)</p> <p>13 BY MR. BURNS:</p> <p>14 Q Oh, just one document under Exhibit 6.</p> <p>15 A Okay.</p> <p>16 Q All right. Now, exhibit -- does</p> <p>17 Exhibit 6 correspond to the third entry in your</p> <p>18 supplemental list of materials, Ratcliffe, N.M.,</p> <p>19 2000, bedrock geologic map of the Cavendish</p> <p>20 quadrangle, Windsor County, Vermont?</p> <p>21 A It does, yes.</p> <p>22 Q Okay. And was there a report associated</p> <p>23 with this map?</p> <p>24 A Not that I -- that I can recall, no.</p> <p>25 Q And when did you obtain this map?</p>	<p style="text-align: right;">Page 64</p> <p>1 kilometers of -- of offset, like the San Andreas</p> <p>2 Fault, up to 300 kilometers there.</p> <p>3 Here, there's a normal shear zone -- and</p> <p>4 I'll just explain that in a second -- a normal</p> <p>5 shear zone that bounds the -- the Chester dome,</p> <p>6 and it's a -- it's a high -- what we would call</p> <p>7 high strain, meaning if you started out with a --</p> <p>8 something like a ball, it would be stretched</p> <p>9 into -- it could be a big, flat pancake or it</p> <p>10 could be a long cigar shape, or it depends on the</p> <p>11 nature of the deformation.</p> <p>12 But basically the shear zone that</p> <p>13 outlines the Chester dome is the -- is part of</p> <p>14 what's responsible for the -- the major</p> <p>15 differences in the temperatures -- the higher</p> <p>16 temperatures that are recorded in the core of the</p> <p>17 dome relative to the units that flank it.</p> <p>18 So, the Hammondsville unit would have</p> <p>19 been up here, and the core of the dome would have</p> <p>20 been up here, and after the faulting, basically</p> <p>21 they would be juxtaposed, and there would be a</p> <p>22 strong temperature and deformation gradient across</p> <p>23 that boundary.</p> <p>24 Q And the last term you used "in</p> <p>25 gradient"?</p>
<p style="text-align: right;">Page 63</p> <p>1 A Again, it would have been at the same</p> <p>2 time as the others, a year ago or so.</p> <p>3 Q Okay. And to what purpose did you put</p> <p>4 the data reflected in this map?</p> <p>5 A I'm sorry. Can you --</p> <p>6 Q To what purpose did you put the data</p> <p>7 reflected in this map or this map itself? What</p> <p>8 did you do with it?</p> <p>9 A Well, so this is -- I can recognize this</p> <p>10 right away. This is the northern end of the</p> <p>11 Chester dome, and so there are these small units,</p> <p>12 OZU -- I think it says OZU. So this is the</p> <p>13 Hammondsville mine, and it's basically at the</p> <p>14 northern end of this map.</p> <p>15 And so, again, an important aspect of --</p> <p>16 of this and the detailed position of that</p> <p>17 ultramafic body or the talc ores that are</p> <p>18 associated with it, is its position relative to</p> <p>19 this fault that outlines the -- the Chester dome.</p> <p>20 Q Again, what is a fault?</p> <p>21 A So a fault is a geologic structure</p> <p>22 across which there is displacement, and that</p> <p>23 displacement could range from -- I mean, we have</p> <p>24 microfaults, so it could be millimeters or</p> <p>25 centimeters of offset, and in some cases, you have</p>	<p style="text-align: right;">Page 65</p> <p>1 A A temperature --</p> <p>2 Q Or gradient?</p> <p>3 A A temperature and -- temperature,</p> <p>4 pressure, and deformation gradient.</p> <p>5 Q And when you say that, what do you mean?</p> <p>6 A Well, I mean that over a short distance,</p> <p>7 you could walk across rocks that record very</p> <p>8 different temperature and pressure conditions</p> <p>9 of -- of metamorphism. In terms of the</p> <p>10 deformation gradient, that would be going from</p> <p>11 rocks that -- I mean, everything is deformed here,</p> <p>12 but that are less deformed into rocks, that are</p> <p>13 more intensely deformed and stretched, and then</p> <p>14 back out into a lower strain or less deformation.</p> <p>15 Q I see. Now, are fissures commonly</p> <p>16 associated with fault lines?</p> <p>17 A They can be, but it depends on, again,</p> <p>18 the pressure, temperature, conditions. So this is</p> <p>19 really -- I mean, this -- this fault zone, the</p> <p>20 temperature gradient across it, again, is kind</p> <p>21 of in the range from, say, 700 degree C to, say,</p> <p>22 550 degrees C. And at those temperatures -- and</p> <p>23 it also depends on the details of the mineralogy,</p> <p>24 but in general that's hot enough where minerals</p> <p>25 are deforming by slip along the crystallographic</p>

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<p style="text-align: right;">Page 66</p> <p>1 planes. So we refer to that as ductile 2 deformation. 3 So when you have deformation occurring 4 under these higher temperature conditions, we tend 5 to not have voids or fissures opening up. That's 6 much more common in low temperature deformation 7 environments where the rocks are deforming 8 brittly. 9 Q Okay. Do you know whether in fact there 10 are fissures associated with this fault line 11 around the Chester dome? 12 MR. FROST: Objection to form. 13 THE WITNESS: I have not seen really any 14 descriptions of such features. Again -- and in my 15 experience, I've actually worked in the shear zone 16 some, so my observation of rocks in the shear zone 17 is that it's more a continuum of ductile 18 deformation. We haven't -- haven't seen, yeah, 19 fractures opening up, filling with other minerals, 20 et cetera. 21 BY MR. BURNS: 22 Q How would you identify a fracture or -- 23 are fracture and fissure synonymous? 24 A Yeah, I mean, we don't really use the 25 word "fissure" in geology so much, or at least not</p>	<p style="text-align: right;">Page 68</p> <p>1 that have moved through there, you might have 2 crystallization of minerals. 3 Q And would that be what you were 4 referring to a few minutes ago when you said -- 5 referred to sort of minerals filling in the 6 fracture? 7 MR. FROST: Objection to form. 8 THE WITNESS: Yeah, I mean -- yeah. 9 BY MR. BURNS: 10 Q As a general principle, when you have 11 lower pressure and lower temperature, are the odds 12 greater that you would have or could have an 13 influx of water or liquids? 14 MR. FROST: Objection to form. 15 THE WITNESS: I mean, fluids will 16 preferentially follow pathways, such as faults and 17 fractures potentially, yeah. But, again, it 18 depends on a lot of variables. Yeah. 19 BY MR. BURNS: 20 Q Okay. I think that moves number 3. 21 And just so I'm sure, was there anything 22 in particular about Exhibit 6 there that impacted 23 or informed your opinions? 24 A Well, again, it's the finding the 25 location of the Hammondsville mine with regard to</p>
<p style="text-align: right;">Page 67</p> <p>1 in my lexicon. But I think, you know, it's pretty 2 similar. I mean, a fracture -- and, again, 3 there's different types of fractures. There are 4 fractures that the rocks just pull apart. There 5 are fractures where there's some, like, little bit 6 of slip along them, and actually there's a slip 7 this way or slip this way, so there's mode 1, 2 8 and 3 of fractures, yeah. 9 Q Okay. So how would you identify, in the 10 field, a fracture? 11 A Uh, well, it's -- usually you would see 12 some -- a feature that crosscuts structural fabric 13 in the rock. So these rocks out here are highly 14 foliated, means that -- what that means is that 15 basically during the deformation, there are planar 16 elements that form. It could be defined by the 17 compositional banding. It could be defined by the 18 preferred orientation of minerals are in the -- in 19 the talc. Often that's the -- all the talc plates 20 would be aligned in that foliation plane. And so 21 there would be some truncation of that -- that 22 fabric. 23 And it depends on when the fracture 24 forms. If it formed very recently, it might just 25 be an -- an open space, but if there are fluids</p>	<p style="text-align: right;">Page 69</p> <p>1 the details of the map. 2 Q Okay. 3 A And moving from there. 4 Q Thank you. 5 I'm now going to hand you Exhibit No. 7, 6 and take No. 6. 7 (Webb Exhibit No. 7 was marked for 8 identification.) 9 THE WITNESS: It would help if I had 10 north up. (Peruses document.) 11 BY MR. BURNS: 12 Q Ready? 13 A Oh. Yes, sorry. 14 Q No, no problem. 15 A I can look at it all day. 16 Q So does -- Dr. Webb, does Exhibit No. 7 17 correspond to the fourth item on your supplemental 18 list of materials, Ratcliffe, 2000, bedrock 19 geologic map of the Chester quadrangle, Windsor 20 County, Vermont? 21 A Yes. 22 Q And was there an associated report? 23 A I -- I don't recall offhand on this one. 24 Q With respect to this map, what was 25 your -- when did you obtain it?</p>

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<p>1 A Again, it would have been at the same</p> <p>2 time.</p> <p>3 Q And what was your purpose in obtaining</p> <p>4 it?</p> <p>5 A Oh, again, just -- I mean, I was just</p> <p>6 sort of gathering the quadrangle maps for the</p> <p>7 region in general. This one, I do not believe we</p> <p>8 see any of the -- the different talc mines, but I</p> <p>9 think this is the southern -- sorry, the more</p> <p>10 southern half of the -- the Chester dome.</p> <p>11 Q I see. So none of the J&J talc mines</p> <p>12 are represented on that map?</p> <p>13 A No. I don't believe so, but I'd have</p> <p>14 to -- can I confer with my report map for a</p> <p>15 moment? Oh, this is not the colored one.</p> <p>16 MR. FROST: Do you want a color -- I'm</p> <p>17 just showing her a color copy of the same page.</p> <p>18 THE WITNESS: Yeah, so this is -- yes,</p> <p>19 this is the southern half of the Chester dome,</p> <p>20 and, no, none of the mines are located in the map</p> <p>21 area here.</p> <p>22 BY MR. BURNS:</p> <p>23 Q Okay. All right. Let's go to Exhibit</p> <p>24 No. 8.</p> <p>25 And this is going to be 8A and B.</p>	<p>1 from you.</p> <p>2 MR. BURNS: Can we mark that as</p> <p>3 Exhibit 9.</p> <p>4 MR. FROST: This is what, Zodiac?</p> <p>5 MR. BURNS: Yeah.</p> <p>6 (Webb Exhibit No. 9 was marked for</p> <p>7 identification.)</p> <p>8 BY MR. BURNS:</p> <p>9 Q Dr. Webb, I've handed you Exhibit 9,</p> <p>10 which I believe corresponds to number 6 on your</p> <p>11 supplemental list, Zodiac, P., 1940, a talc quarry</p> <p>12 near Chester, Vermont; is that correct?</p> <p>13 A That's correct.</p> <p>14 Q And it's published in Rocks & Minerals;</p> <p>15 is that right?</p> <p>16 A Yes.</p> <p>17 Q How, if at all, did this article inform</p> <p>18 your opinions?</p> <p>19 A I looked at this after I had written my</p> <p>20 report, so it's -- it's not reflected in my</p> <p>21 report.</p> <p>22 Q Did it change your opinions at all?</p> <p>23 A No.</p> <p>24 Q Have any impact?</p> <p>25 A No.</p>
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<p>1 (Webb Exhibit No. 8A and 8B were</p> <p>2 marked for identification.)</p> <p>3 BY MR. BURNS:</p> <p>4 Q Dr. Webb, do Exhibits 8A and B relate to</p> <p>5 the fifth entry on your supplemental list of</p> <p>6 materials, Ratcliffe and Armstrong, 2001, bedrock</p> <p>7 geologic map of the Saxtons River in Windham and</p> <p>8 Windsor Counties, Vermont?</p> <p>9 A Yes.</p> <p>10 Q Okay. And was there an associated</p> <p>11 report?</p> <p>12 A Again, I don't remember specifically</p> <p>13 for -- for this one. I'd have to look at the</p> <p>14 website or my files.</p> <p>15 Q And did you obtain these maps at roughly</p> <p>16 the same time as you obtained the preceding maps?</p> <p>17 A Yes.</p> <p>18 Q And were these maps again generally used</p> <p>19 to plot the location of the mines and -- and your</p> <p>20 inquiry into them?</p> <p>21 A Yeah. Again, this -- this one is sort</p> <p>22 of the southwestern end of the -- the Chester</p> <p>23 dome. So I recognize this -- this lobe. None of</p> <p>24 the mines are in this specific map area.</p> <p>25 Q Okay. All right. We can take that map</p>	<p>1 Q When did you first read this?</p> <p>2 A Three weeks ago or so.</p> <p>3 Q So early March?</p> <p>4 A Yes. That's about right.</p> <p>5 Q Okay. Did you -- did you find this</p> <p>6 article yourself or was it provided to you?</p> <p>7 A I found it myself.</p> <p>8 Q Okay. And why were you looking for it?</p> <p>9 A Because I was reviewing the literature,</p> <p>10 again just in general preparation, and I came</p> <p>11 across this article cited in -- I believe it was</p> <p>12 Van Gosen, 2004, and I just thought I should -- I</p> <p>13 realized I hadn't seen it and I thought I should</p> <p>14 look.</p> <p>15 Q And when you say you were reviewing the</p> <p>16 literature, the literature with respect to what?</p> <p>17 A I mean just the things that are -- I've</p> <p>18 cited in my report or in the reliance list, but</p> <p>19 just -- there's so much information that I -- to</p> <p>20 keep nimble, just to kind of constantly trying to</p> <p>21 review and -- and remember.</p> <p>22 Q When you were reviewing the literature,</p> <p>23 did you come across any studies or reports or</p> <p>24 articles that were contrary to your opinions</p> <p>25 expressed in your report?</p>

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<p>1 A No, not really. I mean, I -- I -- as I</p> <p>2 said, I spent some time looking in -- in detail --</p> <p>3 well, a wide variety of literature, and for</p> <p>4 example, that included Van Gosen, et al., 2004,</p> <p>5 and -- and the 2006 articles that I cited in -- in</p> <p>6 my report. Some of those are summary articles,</p> <p>7 and so I really tried to go in and look at the</p> <p>8 primary literature, not to rely on -- on someone's</p> <p>9 summary.</p> <p>10 But, you know, the Van Gosen, 2006,</p> <p>11 seemed relevant to follow up on the details of the</p> <p>12 citations, because in there -- in that report he</p> <p>13 published a map of asbestos localities in Vermont.</p> <p>14 Q Now, you mentioned primary literature.</p> <p>15 What do you mean by that?</p> <p>16 A I mean that I -- so, for example, the</p> <p>17 Van Gosen, 2006, map and digital supplements, what</p> <p>18 Van Gosen put on the map in terms of the</p> <p>19 localities where asbestos was presumably reported</p> <p>20 were not his first order observations. He had a</p> <p>21 citation list of the -- the people who made -- you</p> <p>22 know, presumably said that there was asbestos</p> <p>23 there. And -- and so I -- you know, I drilled</p> <p>24 down into that literature to try and see what</p> <p>25 information was in those articles, if I could</p>	<p>1 know, also the health implications for the people</p> <p>2 locally. So, I mean, you know, that -- it's the</p> <p>3 kind of thing that I think you want to be pretty</p> <p>4 certain about if you make that claim.</p> <p>5 Q Do you know whether Van Gosen was --</p> <p>6 felt pretty certain about it?</p> <p>7 A I have no idea. I mean, I imagine, if</p> <p>8 he put that out there, but I don't know.</p> <p>9 Q Were you ever provided details about the</p> <p>10 years in which the J&J mines were in operation?</p> <p>11 MR. FROST: Objection to form.</p> <p>12 THE WITNESS: I mean, I think I have a</p> <p>13 general sense from the sum of what I've read,</p> <p>14 which includes, you know, testimony in</p> <p>15 depositions, but -- I have an idea, but it -- you</p> <p>16 know, it wasn't -- the exact years weren't really</p> <p>17 critical for what I was doing.</p> <p>18 BY MR. BURNS:</p> <p>19 Q Were you ever informed that J&J sourced</p> <p>20 talc from the Johnson mine?</p> <p>21 A No.</p> <p>22 MR. FROST: Objection to form,</p> <p>23 belatedly.</p> <p>24 THE WITNESS: I mean, not for cosmetic</p> <p>25 purposes.</p>
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<p>1 verify basically the locations that he had shown</p> <p>2 on his map and understand their relationship to</p> <p>3 the -- the talc mines.</p> <p>4 Q Were you able to verify those locations?</p> <p>5 A Well, I was able to look at the</p> <p>6 literature that he cited, but in some cases,</p> <p>7 the -- the articles that he cited as reporting</p> <p>8 asbestos actually cited another article, and when</p> <p>9 I went to follow that trail, there was nothing in</p> <p>10 there in terms of a detailed locality. So I</p> <p>11 actually found that there were several dead ends.</p> <p>12 Q Did that cause you to discount</p> <p>13 Van Gosen?</p> <p>14 A Well, I mean, yeah, it gives me pause</p> <p>15 if -- because obviously there are big implications</p> <p>16 when you publish a map and say there's asbestos</p> <p>17 here, here, here and here, that if I couldn't</p> <p>18 verify the -- you know, the citations that were</p> <p>19 the basis of -- of that map, that -- that's, yeah,</p> <p>20 an issue, I think.</p> <p>21 Q Now, when you say "big implications,"</p> <p>22 what do you mean?</p> <p>23 A Well, property values for people. I</p> <p>24 mean, obviously if -- I know that's been an issue</p> <p>25 up around Mount Belvidere, et cetera, but, you</p>	<p>1 BY MR. BURNS:</p> <p>2 Q Were you provided any information</p> <p>3 whatsoever on the Johnson mine?</p> <p>4 MR. FROST: Objection to form.</p> <p>5 THE WITNESS: No.</p> <p>6 Well, I will say that -- actually</p> <p>7 correct one thing, in the sense that I saw a</p> <p>8 reference to it in the plaintiffs' reports and a</p> <p>9 citation for a Seymour thesis. So I did ask -- I</p> <p>10 wasn't able to access that thesis, so I asked</p> <p>11 counsel to provide that, if possible.</p> <p>12 BY MR. BURNS:</p> <p>13 Q And were you provided it?</p> <p>14 A Yes.</p> <p>15 Q Did you review it?</p> <p>16 A I had a look at it. But, you know, the</p> <p>17 Johnson mine is so far up north and in a different</p> <p>18 portion of the belt that it -- it didn't really</p> <p>19 factor into my opinion.</p> <p>20 And even though it makes reference I</p> <p>21 think to the Hammondsville mine, I -- I wasn't --</p> <p>22 I don't know. A master's thesis isn't -- that</p> <p>23 makes peripheral reference isn't what I'm going to</p> <p>24 consider as like the key piece of information that</p> <p>25 my report would hinge on.</p>

20 (Pages 74 to 77)

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<p>1 Q Is it your opinion then that the areas 2 of the Johnson mine and the Hammondsville mine are 3 geologically distinct then? 4 A Yes. 5 Q Now, in your supplemental materials that 6 were provided last night, right before the maps in 7 Exhibit 3, there is a spreadsheet for the Pooley 8 report in Vermont. 9 A Yes. 10 Q And can you tell me what's reflected 11 here? 12 A So when I reviewed the Pooley report, I 13 created this table to basically write notes about 14 his descriptions of the mineralogy, whether the 15 mineral was a major or minor component of the rock 16 or an accessory mineral, and -- and the different 17 textures that were either described or present in 18 the photomicrographs. 19 Q So these are your notes on the Pooley 20 report? 21 A Yes. 22 MR. FROST: Objection to form. 23 THE WITNESS: I mean, it was a way -- a 24 way to sort of organize the -- the data, yeah. 25 BY MR. BURNS:</p>	<p>1 reading something, I make notes like this to just 2 sort of help process the -- the information. 3 So -- and it gave me a quick way to refer -- if I 4 wanted to refer back to his report to check on 5 something, this gave me sort of a quick way to 6 navigate to, say, a particular sample, et cetera. 7 Q Did you try to be as thorough as 8 possible in -- in recording the information from 9 his report? 10 MR. FROST: Objection to form. 11 THE WITNESS: Yeah, I mean I -- I 12 worked -- as I read the results or the 13 descriptions of a particular sample, I -- I made 14 these notes. So -- I certainly wouldn't be 15 motivated to have it be inaccurate, but -- 16 BY MR. BURNS: 17 Q Okay. And your recollection of the 18 Italian spreadsheet or form, can you talk about 19 that a little bit. Were you doing the same thing? 20 A It's the same thing in terms of 21 headings across the top would relate to the 22 samples that he had petrographic descriptions for. 23 And then the -- sorry, and then in the first 24 column would be the -- the list of the different 25 minerals that were mentioned. And so it would be</p>
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<p>1 Q When did you make these notes? 2 A Oh, I'd say in January probably. 3 Q And that's 2019? 4 A Yes. Yeah. 5 Q Okay. 6 A Well, actually, I'll take that back. 7 The Pooley report would have been sometime earlier 8 for Vermont, but the -- the Italian -- there was a 9 table for the Italian. 10 Q So you have another table for the 11 Italian mine? 12 A It's the same form, yeah. Basically, 13 yeah. 14 MR. BURNS: Jack, if you can find that. 15 MR. FROST: We'll take a look, and we'll 16 figure out if it's in there or not. 17 THE WITNESS: Yeah, it would have been a 18 second tab in the Excel file, I think. 19 MR. FROST: Yeah, we'll take a look. 20 We'll get back to you after a break. 21 MR. BURNS: Sure. 22 BY MR. BURNS: 23 Q What use did you put to this table? How 24 did you use it, if at all? 25 A Well, sometimes -- I mean, I -- as I'm</p>	<p>1 the same format with the major, minor, accessory, 2 and any notes related to the -- the textures 3 observed. 4 Q Now, you prepared this before your 5 original report? 6 A Yeah, the -- the Pooley report from 7 Vermont is actually the -- the first document I 8 ever saw, and it was prior to when I was retained. 9 So this -- it would -- yeah, the first time I saw 10 this report would be back in probably May of 2017. 11 I think I made the table during that summer, 12 but... 13 Q Okay. And with respect to the Italian 14 report? 15 A Again, I think -- I think I saw that -- 16 that prior to this litigation, but that table I 17 created -- I rereviewed the report, I think, as I 18 said, in January and created that table at that 19 time. 20 Q And that's the Italian table, just to be 21 clear? 22 A Yes. 23 Q So the Pooley report for Vermont, you 24 reviewed sometime summer of 2017? 25 A Yes.</p>

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<p>1 Q And created this table?</p> <p>2 A (The witness nods.)</p> <p>3 Q Now, preceding that, there are graphical</p> <p>4 representations that look pretty similar to some</p> <p>5 of the things in your report.</p> <p>6 Can you tell us what the two preceding</p> <p>7 pages encompass?</p> <p>8 A Yeah, so there's -- yeah. It's</p> <p>9 basically this was an early version of the -- the</p> <p>10 table that shows up in -- in my report. There's</p> <p>11 some places where I just had some other notes that</p> <p>12 I -- that I jotted down.</p> <p>13 So -- yeah, it's a bigger spreadsheet,</p> <p>14 so it shows this -- it would be continuous in my</p> <p>15 Excel file, but it shows up on multiple pages</p> <p>16 here.</p> <p>17 Q I see. So --</p> <p>18 A So page 1 would be the first column that</p> <p>19 would line up with page 2, and --</p> <p>20 Q Okay. So the first column would be --</p> <p>21 A The mineral name.</p> <p>22 Q -- mineral and talc, and then the second</p> <p>23 column would be formula. Correct?</p> <p>24 A Correct, yes.</p> <p>25 Q Okay. And what is the next page then?</p>	<p>1 A Yes.</p> <p>2 Q And was that for purposes of the MDL?</p> <p>3 A That was prior to being brought into</p> <p>4 this.</p> <p>5 Q Prior to being brought into this case?</p> <p>6 A Yes.</p> <p>7 Q I see. Were you retained generally or</p> <p>8 was it for a specific litigation?</p> <p>9 A I was retained generally. My</p> <p>10 understanding is there was sort of a -- a</p> <p>11 reorganization, and I have no idea how this works,</p> <p>12 but -- of who deals with --</p> <p>13 MR. FROST: I was going to say, I'd</p> <p>14 instruct you not to talk about what any of the</p> <p>15 lawyers --</p> <p>16 THE WITNESS: Oh, okay.</p> <p>17 MR. FROST: -- have told you about, you</p> <p>18 know, but --</p> <p>19 THE WITNESS: I was asked to sign a new</p> <p>20 retainer in October because of something that, I</p> <p>21 don't know, was reorganized in the structure of</p> <p>22 things, and so I signed a new retainer with</p> <p>23 Tucker & Ellis.</p> <p>24 BY MR. BURNS:</p> <p>25 Q So Tucker Ellis replaces the Shook Hardy</p>
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<p>1 A That would be the final column. So just</p> <p>2 for quick reference, if I had -- I often had the</p> <p>3 mineral table up when I was reading stuff to --</p> <p>4 just to be able to refer to quickly, and also so</p> <p>5 then I pasted in a picture -- again, this is I</p> <p>6 think the same image that's ultimately produced</p> <p>7 in -- in my report about the -- the amphibole</p> <p>8 structure.</p> <p>9 There is a column on, yeah, the</p> <p>10 Fe sites, so the M2, M4, M -- or whatever number,</p> <p>11 all refer to specific lattice sites, and you can</p> <p>12 see them in the image that adjoins that.</p> <p>13 Q Mm-hmm.</p> <p>14 A But the question being where -- where</p> <p>15 does iron live in the mineral lattice in -- in</p> <p>16 different amphiboles.</p> <p>17 Q I see.</p> <p>18 A "Live" not being a great word for that,</p> <p>19 but where does it reside typically.</p> <p>20 Q Flipping past the maps, there are a</p> <p>21 couple of retention letters, one by Tucker Ellis,</p> <p>22 one by Shook Hardy & Bacon; is that right?</p> <p>23 A Yes.</p> <p>24 Q And you were retained by Tucker Ellis in</p> <p>25 October of 2018?</p>	<p>1 retainer.</p> <p>2 A It does, yes.</p> <p>3 Q And the Shook Hardy retainer, which was</p> <p>4 signed back in June of 2017, was that for a</p> <p>5 particular piece of litigation or generally?</p> <p>6 A No, that was just general consulting.</p> <p>7 Q Okay. And your fee there was \$250 an</p> <p>8 hour; is that right?</p> <p>9 A Yes.</p> <p>10 Q And with respect to the Tucker Ellis</p> <p>11 retention, it increased to \$458 an hour; is that</p> <p>12 right?</p> <p>13 A Yes.</p> <p>14 Q And why is that?</p> <p>15 A Well, the -- for one, I had a -- I think</p> <p>16 a better understanding of -- there was more</p> <p>17 expertise on this topic at the time of the</p> <p>18 re-signing, plus it was looking forward to -- I</p> <p>19 mean, looking ahead to work like this. And so in</p> <p>20 my, you know, prior work, I was -- well, there's a</p> <p>21 different level of intensity and commitment and</p> <p>22 inconvenience now, and so the price went up.</p> <p>23 Q I'm sure that everyone on both sides of</p> <p>24 this table can relate.</p> <p>25 Now, following that are I think invoices</p>

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<p style="text-align: right;">Page 86</p> <p>1 that you sent to Tucker Ellis; is that correct?</p> <p>2 Three of them?</p> <p>3 A Sorry, following that, is that -- yes.</p> <p>4 Q And the details of those invoices are</p> <p>5 redacted; is that right?</p> <p>6 A Apparent- -- yes.</p> <p>7 Q Okay. Do you recall whether the</p> <p>8 redacted portions -- I'm not going to ask you what</p> <p>9 they say -- but do you recall whether they</p> <p>10 reflected communications with your counsel?</p> <p>11 A There was some of that in there.</p> <p>12 Q Okay. Was there other</p> <p>13 noncommunication-related detail around your work?</p> <p>14 MR. FROST: Objection to form.</p> <p>15 THE WITNESS: Noncommunication-related,</p> <p>16 you said?</p> <p>17 BY MR. BURNS:</p> <p>18 Q Yes.</p> <p>19 A Yes.</p> <p>20 MR. BURNS: And we would ask, Mr. Frost,</p> <p>21 that y'all review those redactions to determine</p> <p>22 whether there are any pieces that can be produced.</p> <p>23 MR. FROST: I'll take it under</p> <p>24 advisement.</p> <p>25 BY MR. BURNS:</p>	<p style="text-align: right;">Page 88</p> <p>1 THE VIDEOGRAPHER: Going off the record</p> <p>2 at 11:41 a.m.</p> <p>3 (Recess.)</p> <p>4 THE VIDEOGRAPHER: We are back on the</p> <p>5 record at 11:58 a.m.</p> <p>6 BY MR. BURNS:</p> <p>7 Q Welcome back, Dr. Webb.</p> <p>8 So, Dr. Webb, we're going to start going</p> <p>9 through your qualifications, your background and</p> <p>10 experience. It's the next step on our journey.</p> <p>11 In the supplemental materials you --</p> <p>12 your counsel provided last night, there is a CV or</p> <p>13 resume on -- let's see -- it's right past the</p> <p>14 supplemental list.</p> <p>15 A Okay.</p> <p>16 Q Now, is this your current CV?</p> <p>17 A I believe so. I haven't checked what's</p> <p>18 in here, but I did send them an -- an updated CV</p> <p>19 that was included.</p> <p>20 Q Okay. Now, I take it you graduated high</p> <p>21 school in 1990?</p> <p>22 A 1989.</p> <p>23 Q Oh, '89. All right. Well, we're only a</p> <p>24 year apart. But you got your Bachelor of Science</p> <p>25 in geology at UCLA; is that right?</p>
<p style="text-align: right;">Page 87</p> <p>1 Q Okay. Well, I'll put this back up</p> <p>2 because we've hit something of a milestone,</p> <p>3 Dr. Webb, and I think we've largely exhausted most</p> <p>4 of the portions of the subpoena. So we can check</p> <p>5 that off, and we'll go to your qualifications.</p> <p>6 MR. BURNS: Given where we're at, it</p> <p>7 might make sense to take a break.</p> <p>8 MR. FROST: I was going to say we can</p> <p>9 take a break now. I don't know what your plan is</p> <p>10 for lunch. I don't know how long the</p> <p>11 qualifications is going to take. You know, I</p> <p>12 would say if it's going to take a half hour, you</p> <p>13 might want to do that, and then break for lunch.</p> <p>14 If you think it's going take a little longer, we</p> <p>15 can, you know --</p> <p>16 MR. BURNS: Yeah, it might.</p> <p>17 MR. FROST: -- take a really short break</p> <p>18 now, and then maybe break for lunch at 1:00.</p> <p>19 MR. BURNS: Yeah, that's fine. Why</p> <p>20 don't we take --</p> <p>21 MR. FROST: Maybe you may want to take a</p> <p>22 short break, and then --</p> <p>23 MR. BURNS: Sure.</p> <p>24 MR. FROST: -- we'll make it through</p> <p>25 this area.</p>	<p style="text-align: right;">Page 89</p> <p>1 A Yes.</p> <p>2 Q And from there you went to Stanford?</p> <p>3 A Correct.</p> <p>4 Q And in 1999, you received your Ph.D.</p> <p>5 doctoral degree in geological and environmental</p> <p>6 sciences; is that right?</p> <p>7 A That's correct.</p> <p>8 Q Now, did you have a specific area of</p> <p>9 emphasis in your doctoral work?</p> <p>10 A Well, there were two main projects</p> <p>11 thematically, but they basically involved</p> <p>12 development of the same areas of expertise, and</p> <p>13 that is petrology and, more specifically,</p> <p>14 metamorphic petrology being a focus of my work:</p> <p>15 The study of rock structures or rock deformation</p> <p>16 and its relationship to metamorphism; and then</p> <p>17 also the radio- -- excuse me -- the radiometric</p> <p>18 dating of minerals to then understand the -- the</p> <p>19 timing of metamorphism and deformation.</p> <p>20 Q All right. Can you describe what</p> <p>21 radiometric dating of minerals involves.</p> <p>22 A Yeah. So for many elements, there are</p> <p>23 different isotopes, which differ in the number of</p> <p>24 neutrons in the atom. Some of these are</p> <p>25 radioactive, so in particular, my -- the technique</p>

23 (Pages 86 to 89)

<p style="text-align: right;">Page 90</p> <p>1 we do in my laboratory is -- is fundamentally 2 based on the decay of potassium 40 -- that's the 3 isotope number -- to argon 40. 4 And so -- but we do a variation on that 5 that I can describe if you want. But basically, 6 we analyze the -- the isotope ratios of the 7 radioactive parent and the daughter product to 8 determine an absolute age. 9 Q And by "absolute age," what do you mean? 10 A That would be, say, to say -- calculate 11 an age of like 544 million years rather than 12 generally referring back to the Cambrian or 13 something like that. So... 14 Q I see. So in layman's terms, if I could 15 hand you a rock, theoretically you could take it 16 back to your laboratory and date it through that 17 process? 18 A Yeah, as long as -- in my case, as long 19 as there are potassium-bearing minerals. 20 Q I see. And do those attend certain 21 types of rocks? 22 A Yes. It's all a function of the bulk 23 composition of -- of the rock. But, yeah, 24 certain -- certain rocks you can -- are pretty 25 much guaranteed you can find these potassium-</p>	<p style="text-align: right;">Page 92</p> <p>1 ores of pure talc and magnesites, they would not 2 be the ideal targets for that. 3 Q I see. During your doctoral work at 4 Stanford, did you perform any studies or -- or let 5 me leave it there. 6 Did you perform any studies that 7 involved talc as a mineral? 8 A There was talc present in -- in some 9 rocks, yes. 10 Q But did you -- were you focused on the 11 talc itself or focused on some other aspect of the 12 rock? 13 A Well, I was focused on -- I mean, again, 14 the same basic principles, understanding the 15 mineralogy and the textures in different rocks, 16 the relationship of that as deformation, and then, 17 again, based on the -- the thematic problems I was 18 working on, you know, finding other targets for -- 19 for dating. So it wasn't basically focused on -- 20 on talc itself, but... 21 Q Did you do any work that was 22 specifically focused on asbestos? 23 A No. 24 Q Now, your doctoral dissertation was in 25 exhumation of high and ultra high pressure rocks</p>
<p style="text-align: right;">Page 91</p> <p>1 bearing minerals in, yeah. 2 Q I see. Are there certain rocks that are 3 on the other end of that equation where you can 4 assume that you don't have those potassium-bearing 5 mineral -- minerals? 6 A Yes. 7 Q What types of rocks are those? Do you 8 have some examples? 9 A Well, so rocks that don't have 10 significant potassium in them, like the ultramafic 11 rocks, for example, or a quartzite or a marble 12 or -- I mean, sometimes we can do a whole rock 13 analysis. But, yeah, I mean, the -- the -- 14 generally the mineral -- mineralogy is a function 15 of the bulk composition among the other variables 16 of metamorphism. 17 Q I see. So with respect to talc then, 18 it's fair to assume that you're not ordinarily 19 using rocks containing talc mineral -- minerals in 20 your dating process. Is that fair? 21 A Well, there -- there may be the 22 possibility of that, but -- again, it just depends 23 on the bulk composition of the -- of the rock and 24 the -- and the history. 25 But, you know, pure -- like these talc</p>	<p style="text-align: right;">Page 93</p> <p>1 in the Qinling-Dabie -- 2 A Qinling, yeah. 3 Q -- Qinling-Dabie -- is it Dabie or -- 4 A Dobby (phonetic). 5 Q Dobby (phonetic). 6 -- Qinling-Dabie orogen? 7 A Yes. 8 Q Eastern China and -- 9 A The Yagan-Onch Hayrhan metamorphic core 10 complex. 11 Q All right. And we are going to have to 12 spell this -- 13 MR. FROST: I was going to say, we'll 14 get you a list. 15 BY MR. BURNS: 16 Q Can you describe generally what this 17 dissertation was about? 18 A Yeah. So those -- those are actually 19 two projects in that -- that title. So the 20 "Exhumation of high and ultra high pressure rocks 21 in the Qinling-Dabie Orogen," so there we had 22 basically a continental collision that occurred at 23 the end of the Permian, early Triassic, and you 24 had the leading edge of the continental margin 25 went down a subduction zone, down to mantle</p>

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<p style="text-align: right;">Page 94</p> <p>1 depths, like 90, 100 or more kilometers depth, and 2 somehow those rocks came back to the surface. And 3 so in some of those rocks, little bits of carbon 4 turned into microdiamonds and quartz turned into 5 coesite, a high-pressure polymorph, as a function 6 of having reached those high pressures, and 7 somehow they were brought back to the surface. 8 And so when I was in my Ph.D., this was 9 early after the first reports of these ultra high 10 pressure rocks at the surface, so we went to the 11 Qinling-Dabie Orogen, which was one of the largest 12 orogenic belts where this was recorded, to try and 13 again document the different metamorphic 14 assemblages, their relationship to different 15 fabrics that would form during deformation, during 16 exhumation, and also to try and date the timing of 17 when did the rocks first reach those depths and 18 how, and how fast did they come back to the 19 surface. 20 So it's really an integrative piece of 21 metamorphic petrology, structural geology, and 22 again the radiometric dating. 23 Q Did you figure out how they came back 24 up? 25 A Yeah.</p>	<p style="text-align: right;">Page 96</p> <p>1 A Yeah. Well, that -- in the thin 2 section, look at the microstructure and integrate 3 that back into the outcrop and regional scale. 4 Q And you were also able to date the 5 rocks; is that right? 6 A Yes. 7 Q Okay. Now, after you received your 8 Ph.D., it looks like you went to the University of 9 Geneva in Switzerland; is that right? 10 A That's correct, yes. 11 Q And what did you do there? 12 A I -- well, I worked in the -- the 13 argon -- so this is the same type of lab that I 14 have here at UVM, but the argon laboratory, and -- 15 pardon me. 16 Q That's okay. 17 A There I was working with igneous 18 petrologists, and so we were dating some samples 19 from the -- the Andes. 20 Q And from there you went to Syracuse 21 University; is that right? 22 A That's correct. 23 Q And you, it looks like, worked in both 24 the noble gas isotopic research as a research 25 laboratory manager and as an assistant professor?</p>
<p style="text-align: right;">Page 95</p> <p>1 Q How was it? 2 A Plates reorganize and the subduction 3 zone got reactivated as a normal fault system. 4 And so basically, because South China started 5 moving, relative to today's geographic coordinates 6 started moving south again, it basically pulled 7 that continental margin out of the subduction 8 zone. 9 Q Okay. Now, when you mentioned going to 10 the Qinling-Dabie Orogen, did you physically visit 11 the site? 12 A Yes. 13 Q And what did you do while you were on 14 site? 15 A We found outcrops where we observed the 16 metamorphic -- again, metamorphic rock types, and 17 really there, in particular, documenting the 18 structures and taking sample -- oriented samples 19 to then bring back and make thin sections, and 20 look at the petrography and also choose select 21 samples for dating. 22 Q So once you brought those samples back 23 and did the thin sections, you were able to look 24 at the structure of the -- of the rock. Is that 25 fair?</p>	<p style="text-align: right;">Page 97</p> <p>1 A Yes. 2 Q Okay. And what was the focus of your 3 work while you were at Syracuse? 4 A Well, when I first arrived, the lab was 5 an empty room, so I actually helped build and 6 commission the laboratory. And then we turned our 7 attention to different projects. A big focus of 8 my research there was on Papua, New Guinea. 9 Q And the rocks in Papua -- Papua, New 10 Guinea? 11 A Yes. 12 Q I see. What exactly is a noble gas 13 isotopic research? 14 A So argon, neon, helium, they're all 15 noble gases. They have filled outer electron 16 shells, so they don't bond with other elements. 17 Q I see. Just like kings, they don't play 18 well with others, right? 19 A Yeah, they don't need anybody else. 20 Q And from Syracuse, you went to the 21 University of Vermont; is that right? 22 A Yes. 23 Q Okay. And that was in 2009? 24 A I started here in the fall of 2008. 25 Q Okay. And you are still at the</p>

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<p style="text-align: right;">Page 98</p> <p>1 University of Vermont; is that right?</p> <p>2 A That's correct.</p> <p>3 Q And are you an associate professor</p> <p>4 today?</p> <p>5 A I am, yes.</p> <p>6 Q Has there been any particular focus to</p> <p>7 your work here at -- in Vermont?</p> <p>8 A Again, general themes of integrating</p> <p>9 metamorphic petrology and structural geology</p> <p>10 and -- and age dating. I've worked in Papua, New</p> <p>11 Guinea, I've worked in Mongolia, and I've been</p> <p>12 working a lot in -- in Vermont.</p> <p>13 Q When did your work in Vermont begin?</p> <p>14 A Pretty much upon my arrival.</p> <p>15 Q Mm-hmm. And what has been your focus</p> <p>16 there? Is there a particular area, geographic or</p> <p>17 otherwise?</p> <p>18 A It varies. I mean, I guess the Chester</p> <p>19 dome area is the farthest south, and then I've</p> <p>20 worked in the Tillotson Peak complex, so that's</p> <p>21 a -- in the northern part. I mean, generally kind</p> <p>22 of in the Green Mountains generally, but also in</p> <p>23 the Lake Champlain basin.</p> <p>24 Q And what have you been trying to do in</p> <p>25 the Green Mountains? Is there an overarching</p>	<p style="text-align: right;">Page 100</p> <p>1 that resulted in vertical thinning and the</p> <p>2 juxtaposition of the rocks at different</p> <p>3 metamorphic grades.</p> <p>4 Q Are there differences between the</p> <p>5 eastern margin and the western margin?</p> <p>6 A We've looked at some over there. Our --</p> <p>7 the -- I mean, this is the beginning of that sort</p> <p>8 of investigation. But the reason I mentioned the</p> <p>9 eastern margin specifically is because there,</p> <p>10 there happen to be roads that cross good exposures</p> <p>11 of rock types where you can do a sampling transect</p> <p>12 from the core through the attenuated mantle unit.</p> <p>13 So it's more about the opportunity -- the sampling</p> <p>14 opportunities there.</p> <p>15 Q Roads have been cut through that?</p> <p>16 A Right. You might -- well, it's not very</p> <p>17 green here now, but -- the -- the foliage poses</p> <p>18 some challenges at times, yeah.</p> <p>19 Q And what have you done on the</p> <p>20 southern -- on the Athens dome region or that</p> <p>21 southern region?</p> <p>22 A Again, just in particular, some very</p> <p>23 good outcrops there that allow for some more</p> <p>24 detailed study.</p> <p>25 Q Have you reached any conclusions or</p>
<p style="text-align: right;">Page 99</p> <p>1 theme to your work there?</p> <p>2 A Well, it -- it depends. Again, there's</p> <p>3 a very complex geologic and tectonic history. You</p> <p>4 know, we have these very beautiful, detailed</p> <p>5 geologic maps, but there's a lot of room for</p> <p>6 refinement in some of the ages of events, and</p> <p>7 particularly looking at the -- the reactivation of</p> <p>8 structures that formed earlier in the history. So</p> <p>9 you might have a fault that's formed during the</p> <p>10 tectonic orogeny that a hundred million later --</p> <p>11 million years later, another continental block</p> <p>12 comes and then slams into North America, and that</p> <p>13 fault moves again.</p> <p>14 But, again, being able to look at the</p> <p>15 microstructure and choose targets for dating to</p> <p>16 resolve those different events.</p> <p>17 Q Now, you mentioned you had worked out at</p> <p>18 the Chester dome. What have you -- what has been</p> <p>19 your experience out there?</p> <p>20 A I have a master's student currently</p> <p>21 working on the -- the eastern margin of the -- the</p> <p>22 dome, and also the southern portions, which</p> <p>23 technically some people call the Athens dome. But</p> <p>24 we're basically trying to refine the timing of the</p> <p>25 formation of that shear zone, the one I described</p>	<p style="text-align: right;">Page 101</p> <p>1 dating?</p> <p>2 A No, this is -- we're in -- in progress</p> <p>3 right now.</p> <p>4 Q I see. And we've used the term "dome" a</p> <p>5 lot. Can you describe for the record what a dome</p> <p>6 is?</p> <p>7 A Yeah. So, again, it relates to folding</p> <p>8 of the rocks. So, you know, there are layers</p> <p>9 of -- of rocks, say, and tectonic forces cause</p> <p>10 folding. And so the Chester dome is -- well,</p> <p>11 again, there's multiple events that have done</p> <p>12 this. There was first sort of intense north-south</p> <p>13 stretching, and then the Acadian orogeny resulted</p> <p>14 in this sort of east-west folding. So that's</p> <p>15 partly how -- why we have this long north-south</p> <p>16 structure. So...</p> <p>17 Q Now, on the second page of your CV,</p> <p>18 there's an area for Technical Expertise.</p> <p>19 A Mm-hmm.</p> <p>20 Q The first entry there refers to</p> <p>21 Nu Noblesse, MAP 216 and Micromass 5400 noble gas</p> <p>22 mass spectrometers for argon 40 and argon 39</p> <p>23 thermochronology.</p> <p>24 And again, are those tests or processes</p> <p>25 to date rock?</p>

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<p style="text-align: right;">Page 102</p> <p>1 A Yes.</p> <p>2 Q And I take it those are specific tests</p> <p>3 you would -- and those are the processes you</p> <p>4 enlisted, right?</p> <p>5 A I'm sorry?</p> <p>6 Q Are those specific testing devices or</p> <p>7 testing processes, rather, that you would use?</p> <p>8 A Yeah. These are magnetic sector, mass</p> <p>9 spectrometers, so that's -- yeah, how we're doing</p> <p>10 the isotopic analyses.</p> <p>11 Q Okay. Next one is Balzers Prisma</p> <p>12 QME 200, and that's another mass spectrometer?</p> <p>13 A Yes, that's a quadrupole mass</p> <p>14 spectrometer, so -- as opposed to taking up one of</p> <p>15 these large tables, it's more of a football-shaped</p> <p>16 item, but that is used, yes, specifically for that</p> <p>17 uranium-thorium-helium dating technique.</p> <p>18 Q Okay. Next is design, construction and</p> <p>19 maintenance of ultra-high vacuum extraction lines.</p> <p>20 A Yes.</p> <p>21 Q What does that involve?</p> <p>22 A That's the front end to my mass</p> <p>23 spectrometer. So there's actually argon in the</p> <p>24 air we're breathing right now, and so we have</p> <p>25 to -- we've built this stainless steel line that</p>	<p style="text-align: right;">Page 104</p> <p>1 Q And what are those used for?</p> <p>2 A For detailed elemental analyses. So you</p> <p>3 might want to look at the chemical zoning in</p> <p>4 minerals. You might want to measure absolute</p> <p>5 concentrations of different elements, because we</p> <p>6 can then use that information to do</p> <p>7 thermobarometry to determine the -- again, the</p> <p>8 pressures and temperatures of -- of the formation</p> <p>9 of a mineral that that records.</p> <p>10 Q Okay. The next one is secondary</p> <p>11 ionization mass spectrometry.</p> <p>12 A Yes.</p> <p>13 Q What does that involve?</p> <p>14 A So that's a different type of mass</p> <p>15 spectrometer where you basically ablate a sample</p> <p>16 with an ion beam. That ion beam basically drills</p> <p>17 a hole and ionizes material.</p> <p>18 So this is in situ work. So you might</p> <p>19 be making a 10 micron spot within a zircon grain,</p> <p>20 and then -- then those ionized atoms -- or they're</p> <p>21 ions at that point -- are analyzed, say, for</p> <p>22 uranium-lead isotopes.</p> <p>23 So it can be used for, again,</p> <p>24 radiometric dating or I've also used it for a</p> <p>25 technique related to the -- titanium concentration</p>
<p style="text-align: right;">Page 103</p> <p>1 is -- inside that envelope, stainless steel</p> <p>2 envelope, pressures are about 13 orders of</p> <p>3 magnitude lower than the pressure we're enjoying</p> <p>4 today, because we have to get all that background</p> <p>5 argon out of the system in order to be able to</p> <p>6 measure precisely what comes out of our samples.</p> <p>7 Q Then you list management of radioactive</p> <p>8 materials and isotopic inventories. Is that</p> <p>9 primarily argon?</p> <p>10 A Yes. In order to get to this argon 40,</p> <p>11 39, from that potassium-argon technique, we</p> <p>12 actually have to irradiate our samples with fast</p> <p>13 neutrons and a reactor.</p> <p>14 Q I see. Is that done under controlled</p> <p>15 conditions of --</p> <p>16 A Yeah, I mean, I'm not involved with</p> <p>17 the -- the nuclear reactor. That's a service</p> <p>18 that's provided to us, yeah.</p> <p>19 Q Yep. Other analytical experience, you</p> <p>20 have electron microprobe analyses. What does that</p> <p>21 involve?</p> <p>22 A So basically that's a scanning electron</p> <p>23 microscope that has WDS protectors that are</p> <p>24 higher -- generally higher precision detectors</p> <p>25 than the EDS or EDAX.</p>	<p style="text-align: right;">Page 105</p> <p>1 in quartz. Again, a thermometer or barometer-type</p> <p>2 technique.</p> <p>3 Q Have you ever used a scanning electron</p> <p>4 microscope to identify particular minerals?</p> <p>5 A Yes.</p> <p>6 Q What type of minerals?</p> <p>7 A I mean, it depends on what's -- what's</p> <p>8 on the menu in your rock, but -- well, the</p> <p>9 amphiboles, garnet, muscovite, biotite. Yeah, I</p> <p>10 mean --</p> <p>11 Q Okay. Next one, laser ablation</p> <p>12 inductively coupled mass spectrometry.</p> <p>13 A Yes.</p> <p>14 Q That's a mouthful.</p> <p>15 A Yeah. So that one you -- again, it's a</p> <p>16 mass spectrometer, a magnetic sector mass</p> <p>17 spectrometer, but in this case the -- the</p> <p>18 liberation of atoms from the sample is done</p> <p>19 generally with an excimer laser, so that's in the</p> <p>20 UV range of the spectrum. So very short</p> <p>21 wavelength, high energy laser that, again, can</p> <p>22 drill a spot into -- a 10, 15, 20 micron spot into</p> <p>23 a mineral grain so you can actually date different</p> <p>24 zones in minerals. So that -- that's used for</p> <p>25 uranium-lead dating of zircon, for example.</p>

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<p style="text-align: right;">Page 106</p> <p>1 Q And the last one, just to make sure we 2 get them all, cathodoluminescence imaging? 3 A Yeah. So that's again using a scanning 4 electron microscope, but a cathodoluminescence 5 detector basically -- well, you can see different 6 things. Again, that was part what I used for the 7 titanium and quartz. So if you were looking at 8 quartz with that technique, zones in the mineral 9 that had higher titanium concentrations would show 10 up brighter, for example. So you could identify 11 zoning, and then identify -- use those maps of 12 zones to target where you would drill into either 13 with the ion beam or subsequent analyses. 14 THE REPORTER: Subsequent what? 15 THE WITNESS: Analyses, yeah. 16 BY MR. BURNS: 17 Q And the next entry in your CV is 18 consulting experience. And you list from 2007 to 19 present the work you've done for law firms for 20 J&J; is that right? 21 A Yes. 22 MR. FROST: Objection to form. It's 23 2017. 24 MR. BURNS: Yeah, 2000 -- I said '7. 25 BY MR. BURNS:</p>	<p style="text-align: right;">Page 108</p> <p>1 are -- are sited, how they're bonded. 2 Q Mm-hmm. And how would you contrast that 3 with a petrologist? 4 A I'm generally looking at rock systems. 5 So rather than -- I mean, I certainly use 6 mineralogy in order to determine what minerals I'm 7 looking at, but then what I'm interested in, after 8 the mineral ID, is understanding the relationships 9 between different minerals. Because you might 10 have different assemblages in a rock that, again, 11 record different parts of that rock's history. 12 So, yeah, using mineralogy and mineral 13 structures, and again, I also get into the 14 structural geology side, but it's -- it's really 15 trying to understand the -- the formation and the 16 evolution of rocks, but what they record in terms 17 of geologic and tectonic processes. 18 Q I hand you what we'll mark as 19 Exhibit 10, Dr. Webb. 20 (Webb Exhibit No. 10 was marked 21 for identification.) 22 MR. FROST: Thank you. 23 BY MR. BURNS: 24 Q Now, is this your bio on the University 25 of Vermont system?</p>
<p style="text-align: right;">Page 107</p> <p>1 Q 2017 to the present, right? 2 A Yes. 3 Q Okay. I almost snuck that one past your 4 counsel, but I failed. 5 Have you done any other consulting 6 experience for -- in litigation? 7 A No. 8 Q Okay. Have you done any other 9 consulting experience for industry? 10 A No. Not consulting, no. 11 Q Okay. Do you consider yourself a 12 mineralogist? 13 A I certainly use mineralogy, so, I mean, 14 there's kind of a spectrum of expertise out there. 15 So I would describe myself as a -- as a 16 petrologist rather than a mineralogist, but I 17 certainly do have some expertise in mineralogy. 18 Q What's -- what's the difference between 19 those two? 20 A Well, most typically, if someone 21 describes themselves as a mineralogist, then -- 22 for example, the faculty member in our department, 23 he is an expert in the structures of apatite 24 crystals, and so is looking to determine, yeah, 25 the mineral structure where different elements</p>	<p style="text-align: right;">Page 109</p> <p>1 A It looks like it, yes. 2 Q Okay. And similar to what we've been 3 discussing, on the back page it lists your areas 4 of expertise and a researcher in tectonics and 5 thermochronology, correct? 6 A Yes. 7 Q All right. And under "Teaching 8 Research," there are a couple of things I wanted 9 to understand a little more fully. 10 First, in the first sentence it says: 11 "I am a field-based geologist." 12 What is a field-based geologist? 13 A Well, in that -- in many cases I'm 14 actually out in the field making structural 15 measurements, collecting oriented samples. That 16 kind of depends on the nature of -- of the 17 question that I'm trying to address, but it means 18 that I have a skill set that allows me to do that 19 as needed. 20 Q And what is that skill set? 21 A Well, the ability to recognize different 22 rock types in the field, the ability to recognize 23 and document structures, to make the appropriate 24 measurements. For example, the orientation of 25 foliations, or we also have lineations. Minerals</p>

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<p style="text-align: right;">Page 110</p> <p>1 can be elongated or pebbles can be stretched, for 2 example. All this relates again to the structural 3 evolution of -- of the rocks. 4 Q All right. Now, in the next paragraph 5 it says you teach courses in geochronology, 6 petrology, microstructural analysis and tectonics. 7 And then, "In the classroom and in 8 practice, my students and I integrate analytical 9 data with observations at microscopic to 10 continental scales to try and understand how rocks 11 and regions evolve in space and time, and the 12 tectonic processes that shape them." 13 Did I read that correctly? 14 A Yes. 15 Q Okay. Now, when you refer to 16 "integrating analytical data with observations," 17 what -- what are you referring to there? 18 A Well, it -- it depends on, again, the -- 19 the specific study at hand, but again, I -- in my 20 work, let's say if I want to date a mineral and 21 we -- the mass spectrometer spews out some 22 information that we calculate an age from, that 23 age is only as good as my ability to interpret 24 what it means. 25 So that means that I have to understand</p>	<p style="text-align: right;">Page 112</p> <p>1 Q No, fair enough. And really I'm just 2 saying that you described a pretty unique, I 3 think, field-based skill set, one that maybe I 4 wish I had. I would love to be able to look at a 5 hillside and -- and take an instant view of the 6 rocks there and how they fit into the structure. 7 But what I was getting at is those 8 field-based skills allow you to put the rock or 9 mineral you're examining into that context, the 10 context that's found in the field; is that right? 11 A Yes. I mean, it's also a skill set that 12 allows me to work with others. So a lot of the 13 analyses done in my lab are people who have 14 brought samples to us, and so in those cases, I'm 15 generating ages for them, but need to be heavily 16 involved in helping them interpret it. 17 So that field-based skill set also 18 allows me to ask them the appropriate questions to 19 get at that interpretation or give them advice in 20 advance about sampling strategies they might want 21 to employ. 22 Q Okay. In your professional career, have 23 you ever conducted any research on -- aside from 24 the litigation context, on talc as a mineral? 25 A Not specifically focused on it, no.</p>
<p style="text-align: right;">Page 111</p> <p>1 the context of the mineral I dated in the rock. I 2 have to understand the context of that rock in an 3 outcrop. I need to understand the context of that 4 outcrop in the -- sort of the map scale. 5 And so we're integrating the -- the 6 isotopic data. We're integrating the observations 7 of the minerals and the mineral assemblages, and 8 their relationship to deformation, coupled with 9 field measurements. 10 Again, it depends on the study what -- 11 what all is at play, but also, you know, 12 integrating this with the existing literature out 13 there, which generally drives the nature of the 14 question. 15 Q Right. And I'm going to assume your 16 field-based skill set assists in that process by 17 allowing you to observe the minerals, rocks in 18 question in the area in which they occur, and 19 juxtaposed against other formations or other rocks 20 or minerals, right? 21 MR. FROST: Objection to form. 22 THE WITNESS: Yeah, in part. But 23 again -- yeah, I'm sorry, I think I lost the 24 thread there. It was a long one. 25 BY MR. BURNS:</p>	<p style="text-align: right;">Page 113</p> <p>1 Q And same question with respect to 2 asbestos. 3 A No. 4 Q Okay. How does a petrologist differ 5 from a geologist? 6 A Well, there are geologists who are 7 entirely focused on the fossil record or they 8 might be really an expert in a certain kind of 9 structural geology. So geology is more broad 10 about, you know, the study of the earth and -- and 11 rocks, whereas petrology, again, is really looking 12 at the mineral assemblages and the mineral 13 textures to get at how did that rock initially 14 form and what are the processes that's altered it 15 since its formation. 16 Q So you're not a professional geologist, 17 I would assume. 18 A How do you define "professional 19 geologist"? 20 Q Or a geologist generally. 21 A Oh, I'm definitely a geologist. 22 Q Okay. So the greater subsumes the 23 lesser or the smaller. 24 A Petrology is a specific -- more specific 25 area of geology.</p>

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<p style="text-align: right;">Page 114</p> <p>1 Q Of geology. Okay. Bad question. I 2 appreciate it. 3 A Well, I -- yeah. 4 Q Have you ever published any peer- 5 reviewed articles on asbestiform amphiboles in 6 talc? 7 A No. 8 Q Have you ever presented on that topic in 9 any capacity? 10 A No. 11 Q Have you ever published any peer- 12 reviewed articles on the methodological approaches 13 for the identification of asbestiform amphiboles 14 in talc? 15 A No. 16 Q Have you ever presented on that topic? 17 A No. 18 Q Have you ever -- in the context of -- in 19 the journal context, have you ever served as a 20 reviewer? 21 A Yes. 22 Q Okay. Have you ever reviewed any 23 articles or other materials on any issues 24 involving asbestos in talc? 25 A Not asbestos specifically. I mean,</p>	<p style="text-align: right;">Page 116</p> <p>1 example. I'm also aware of the Kerrigan thesis 2 that looked at experiments in which they were 3 seeing if they could grow asbestiform talc. So, 4 yeah. 5 Q Putting aside the litigation context, 6 have you ever participated in any discussions or 7 fora or conferences involving those topics 8 relating to asbestos in talc? 9 A No, not specific to them, no. 10 Q Have -- have you personally ever 11 identified any asbestiform amphibole materials in 12 a talc sample? 13 A No. 14 Q Have you ever examined any talc samples 15 for that purpose? 16 A No, not for that purpose, no. 17 Q Have you ever examined any talc samples 18 generally? 19 A Yes. 20 Q For what purpose? 21 A General petrology. I mean, if we're 22 talking about rocks with talc in them, then we've 23 seen some of that in the rocks from China and 24 Papua, New Guinea, I think, but also in the 25 petrology collection for teaching, putting</p>
<p style="text-align: right;">Page 115</p> <p>1 there's been talc in rocks in papers that I've 2 reviewed, but -- 3 Q Okay. Specifically about the talc or -- 4 A No. I mean, you know, again, that's 5 part of an assemblage that's being interpreted in 6 the context of the assemblage, et cetera. 7 Q Have you conducted any work with 8 graduate students on any issues involving asbestos 9 in talc? 10 A No. 11 Q Are you aware of any student thesis or 12 dissertations on any issue involving asbestos in 13 talc? 14 MR. FROST: Objection to form. 15 THE WITNESS: Am I -- 16 BY MR. BURNS: 17 Q Aware. 18 A Aware? 19 Q Mm-hmm, generally. 20 A Yes. 21 Q Okay. And what's your general 22 awareness? 23 A Well, I know -- I mean, some of the 24 papers I've cited have come out are first authored 25 by students who worked with Mickey Gunter, for</p>	<p style="text-align: right;">Page 117</p> <p>1 together labs, et cetera. 2 Q Okay. Do you plan to offer any opinions 3 in this case regarding the appropriate technique 4 for examining cosmetic talc for the presence of 5 asbestos? 6 A No. 7 Q Does your department possess a 8 transmission electron microscope? 9 A The department does not. There's one in 10 the medical school. 11 Q What about -- same question for a 12 scanning electron microscope. 13 A There's one in the -- the medical 14 school, and there's a new one coming this spring. 15 I'm a co-PI on an NSF grant that was funded to 16 allow UVM to purchase an SE/SEM instrument. 17 Q You said co-PI. What is a PI? 18 A Co-principal investigator. So there was 19 a lead PI out of the physics department, and then 20 I'm one of, say, five PIs on the grant. 21 Q I see. Have you ever been involved in 22 research or work designed to investigate the 23 presence of asbestos materials in any geologic 24 formation? 25 A Not specifically for that purpose, no.</p>

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<p style="text-align: right;">Page 118</p> <p>1 MR. BURNS: I think we're at a lunch 2 stopping point. 3 MR. FROST: Yeah, 12:45, sounds about 4 right. 5 MR. BURNS: All right. Great. 6 THE VIDEOGRAPHER: Going off the record 7 at 12:41. 8 (Lunch recess.) 9 THE VIDEOGRAPHER: We're back on the 10 record at 2:00 p.m. 11 BY MR. BURNS: 12 Q Good afternoon, Dr. Webb. 13 Dr. Webb, we are painfully close to 14 checking off the qualifications box on this -- 15 this little sketch I made. 16 Just one general question that I was 17 hoping you could describe for us. When you go out 18 into the field to collect samples, what process do 19 you generally do when you go out there? What are 20 you looking for? Can you describe that generally? 21 A Yeah, I mean, it depends on what's known 22 and documented for the region already. So that -- 23 you usually build off of the existing knowledge 24 base. But -- so usually we're looking for fresh 25 outcrops with 3D exposure so that you can actually</p>	<p style="text-align: right;">Page 120</p> <p>1 in the lab and, say, make -- cut the rock relative 2 to a specific orientations. 3 Q And by orientations, are you referring 4 to sort of how it was oriented in the ground 5 before you took it so that you know where north, 6 south, you know, up, down is? 7 A Uh, yeah, it depends. I mean, you know, 8 so if -- if this is a rock and these pages are a 9 planar fabric in the rock, the foliation will 10 often cut perpendicular to the foliation so that 11 you see the -- 12 Q The layers. 13 A -- the layering rather than just looking 14 at one plane in the rock. If there is a 15 lineation, that usually relates to the 16 deformations, so the transport direction of one 17 piece of rock relative to a lower piece. And 18 often we'll -- if that's present, we'll cut 19 perpend- -- sorry, parallel to that, because 20 that's how we would observe the rotation of 21 minerals that might tell us the way the fault was 22 moving. Or -- 23 Q Okay. Thank you. 24 Now, you mentioned you would look for 25 fresh outcrops or 3D exposure. What do -- what do</p>
<p style="text-align: right;">Page 119</p> <p>1 see something, rather than just a moss-covered 2 rock surface, for example. 3 Again, to make observations about the -- 4 the rock types, any observations that can made -- 5 be made about the mineralogy in detail, but it 6 depends on the size of the minerals in -- in the 7 rocks. Again, looking to make observations and 8 document structural orientations, again about the 9 planar or linear elements that might be present in 10 a rock as a function of its deformation history. 11 So, I mean, those are -- are generally 12 the -- the sort of categories of -- of 13 observations, yeah. 14 Q Now, when you take the specimen, how do 15 you physically do that? Are you chipping off a 16 specimen? Are you picking it up off the ground? 17 I guess it really depends. 18 A I don't usually rely on things that are 19 on the ground, because you can't. I've left 20 plenty of rocks places where they didn't originate 21 from. 22 So -- so usually it's a hammer and 23 chisel, and most often I'm working with oriented 24 samples. So we would measure a feature and mark 25 it in the field, and that way we can reorient it</p>	<p style="text-align: right;">Page 121</p> <p>1 you mean by 3D exposure? 2 A Well, again, it's this idea that in 3 order to make these -- what we would call 4 kinematic observations relate -- how things are 5 rotating, you need a rock exposure that allows you 6 to look at an exposure that's perpendicular to the 7 foliation and parallel to the lineation. 8 In other words, you could -- if 9 something was rolling like that (demonstrative), 10 you could -- 11 Q Yeah. 12 A -- you could see that as opposed to it 13 coming down the barrel at you. So that 3D aspect 14 is important for getting those certain 15 perspectives at times. 16 Q What type of sites do you look at or 17 look for to find that, you know, fresh outcrops or 18 3D exposure? You had mentioned a road before. 19 A Yeah, so road cuts are -- are often our 20 best window into the rocks, or perhaps in rivers. 21 You know, yeah, I've certainly been in quarries 22 before, et cetera, but -- 23 Q Mines? 24 A If they're aboveground, I mean, yeah. 25 I've never been in an underground mine.</p>

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<p style="text-align: right;">Page 122</p> <p>1 Q Okay. Now, once you take the actual</p> <p>2 sample, I assume that you are taking it back to</p> <p>3 the lab to perform certain tests or examinations</p> <p>4 upon it. Right?</p> <p>5 A Yes. Usually we take it back to the --</p> <p>6 to the department, and there is a rock-cutting</p> <p>7 facility, so we'll cut those oriented chips out of</p> <p>8 the rock to send away to have thin sections made,</p> <p>9 petrographic thin sections.</p> <p>10 Q And then what do you do with the</p> <p>11 petrographic thin sections?</p> <p>12 A I look at them under a petrographic</p> <p>13 microscope, polarized light microscope, to make</p> <p>14 mineral identification, to observe the textural</p> <p>15 relationships between minerals. That, again,</p> <p>16 might relate to relative ages or metamorphic</p> <p>17 reactions that might be frozen or captured in a</p> <p>18 sample, and also the microstructural observations</p> <p>19 about, say, shear sense. As I said, the vorticity</p> <p>20 or the rotation of -- of minerals that might tell</p> <p>21 us about the type of faulting or deformation that</p> <p>22 was occurring. And then in the case of the</p> <p>23 geochronology, selecting appropriate rocks to</p> <p>24 target for dating.</p> <p>25 Q And that's really been the focus of your</p>	<p style="text-align: right;">Page 124</p> <p>1 And that will take us to the efforts you</p> <p>2 made in preparing to give your opinions in this</p> <p>3 case. And I'm going to get to those specific</p> <p>4 opinions a little bit later, hopefully not too</p> <p>5 much later, recognizing it is the afternoon.</p> <p>6 What was your charge in this case? What</p> <p>7 were you asked to do?</p> <p>8 A I was asked to study and -- and provide</p> <p>9 an explanation of the petrological processes that</p> <p>10 are associated with the high purity talc deposits.</p> <p>11 So, again, you know, these pressure, temperature,</p> <p>12 bulk composition type questions.</p> <p>13 Of course, a specific question I was</p> <p>14 asked to address is what is the relationship or</p> <p>15 not of -- of asbestos to -- to the talc deposits</p> <p>16 at issue. Yeah.</p> <p>17 Oh, as well, and part of that charge, of</p> <p>18 course, was to read and respond to the -- the</p> <p>19 reports of Drs. Cook and Krekeler. And also if</p> <p>20 there was information that I had or was able to</p> <p>21 synthesize on -- on, again, sort of at the mineral</p> <p>22 structure scale. The differences, for example, in</p> <p>23 the chemical resistance or the -- of, say,</p> <p>24 asbestiform amphiboles versus non-asbestiform</p> <p>25 amphiboles.</p>
<p style="text-align: right;">Page 123</p> <p>1 particular research is ultimately getting to that</p> <p>2 last point, the dating of those rocks, right?</p> <p>3 A Not exclusively, no.</p> <p>4 Q How not exclusively?</p> <p>5 A Because I've had some projects where</p> <p>6 there's been no geochronology, and it's been more</p> <p>7 about the petrology, again understanding the</p> <p>8 temperature and pressure conditions. So, again,</p> <p>9 it just depends on what's known already and what</p> <p>10 the new questions are.</p> <p>11 Q I see. And I take it during those steps</p> <p>12 of the micro- -- pardon me.</p> <p>13 During those steps in the lab, you are</p> <p>14 carefully recording each of these observations; is</p> <p>15 that right?</p> <p>16 A Yeah. I mean, again, it depends on what</p> <p>17 the -- the nature of the project is. But, yes, we</p> <p>18 make a record of the -- the mineralogy, the</p> <p>19 structures, et cetera, yeah.</p> <p>20 Q How do you make a record of where the</p> <p>21 rock was sourced?</p> <p>22 A Generally, we take GPS coordinates</p> <p>23 associated with the sampling locations.</p> <p>24 Q Well, I think we can safely cross</p> <p>25 qualifications off our list.</p>	<p style="text-align: right;">Page 125</p> <p>1 Q Mm-hmm. Can you describe in general</p> <p>2 terms the methodology you employed in reaching and</p> <p>3 rendering your opinions in this case?</p> <p>4 A Yeah. So, I mean, I -- I really used</p> <p>5 the same approach that I would approach any aspect</p> <p>6 of my science, whether it's writing a paper or a</p> <p>7 peer review. But, again, to try and do an</p> <p>8 extensive search of the peer-reviewed literature,</p> <p>9 and also -- I mean, in that search I found also</p> <p>10 USGS reports, as we've discussed earlier today.</p> <p>11 And really to look in -- in detail, and, again, I</p> <p>12 mentioned that I tried to really dig into the</p> <p>13 primary citations, who were the first people to</p> <p>14 look at these rocks, what did -- you know, what</p> <p>15 did they see, and try and confirm things that</p> <p>16 had -- were then included in -- in later summary</p> <p>17 type papers that I also saw.</p> <p>18 But, again, what I'm really concerned is</p> <p>19 as a petrologist is the system of rocks, and so,</p> <p>20 you know, not only was my interest related to</p> <p>21 anything written about the talc bodies themselves</p> <p>22 but also the surrounding rocks. Because in order</p> <p>23 to understand the history that the -- the talc</p> <p>24 ores experienced, you have to dig into rocks</p> <p>25 around them of different bulk compositions.</p>

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<p style="text-align: right;">Page 126</p> <p>1 Different rocks have the potential to record</p> <p>2 different aspects, in part because they might have</p> <p>3 a different strength or they might have minerals</p> <p>4 that are more stable over a broader range of</p> <p>5 pressure and temperature conditions.</p> <p>6 So this was all part and parcel in terms</p> <p>7 of trying to understand, as I was describing,</p> <p>8 the -- the structure of -- of the dome in the case</p> <p>9 of Vermont, you know, how differences between the</p> <p>10 core and those mantling units where the -- the</p> <p>11 talc mines are -- are located, the details of the</p> <p>12 pressure, temperature, deformation histories.</p> <p>13 So, again, I wasn't only just looking at</p> <p>14 the talc ores, I was also looking at the reports</p> <p>15 of asbestos in Vermont and really trying to</p> <p>16 understand the petrology of those systems. Again,</p> <p>17 relative timing, pressure, temperature, conditions</p> <p>18 of formations, differences maybe that in fluid</p> <p>19 chemistry that might impact how metamorphic</p> <p>20 processes play out.</p> <p>21 So, again, my synthesis was a range of</p> <p>22 scales from sort of, you know, all of Vermont and</p> <p>23 its cumulative tectonic history to, you know,</p> <p>24 reading works that described observations made in</p> <p>25 petrologic thin sections, you know, again, down at</p>	<p style="text-align: right;">Page 128</p> <p>1 before me.</p> <p>2 So if there -- if I feel like there is a</p> <p>3 big gap in that information, that would drive that</p> <p>4 need to go out into the field to collect samples,</p> <p>5 and I just didn't arrive at that position in this</p> <p>6 case.</p> <p>7 BY MR. BURNS:</p> <p>8 Q Well, let me -- let me focus on the</p> <p>9 Argonaut mine for a moment. Are you aware of any</p> <p>10 peer-reviewed work or any other reports relating</p> <p>11 to samples taken in the Argonaut mine relative to</p> <p>12 talc and asbestos?</p> <p>13 A The Argonaut mine. Well, other than, I</p> <p>14 think it's, the Buzon thesis where there were some</p> <p>15 samples that were analyzed by, I think it's,</p> <p>16 Marian Buzon during her Ph.D., I haven't seen</p> <p>17 anything in -- in the published literature about</p> <p>18 the samples from that mine except for her work, I</p> <p>19 believe.</p> <p>20 Q So, for example, you spoke about gaps in</p> <p>21 the record. Why is that not a gap in the record</p> <p>22 you would be interested in?</p> <p>23 A Well, again --</p> <p>24 MR. FROST: Objection to form.</p> <p>25 THE WITNESS: Again, I mean, basically</p>
<p style="text-align: right;">Page 127</p> <p>1 the micron scale.</p> <p>2 Q Okay. Well, one of the things that</p> <p>3 surprise me a bit in reading your report, just to</p> <p>4 be frank, is that the methodology you just -- just</p> <p>5 described and employed in this case differs from</p> <p>6 some of the science you have conducted before as a</p> <p>7 field-based geologist in that you did not</p> <p>8 apparently go out to, for instance, the Vermont</p> <p>9 sites and take samples, and bring those samples</p> <p>10 back to your -- to your laboratory to determine</p> <p>11 whether asbestos may be contained in the</p> <p>12 underlying rock, what that relationship might be</p> <p>13 to the talc.</p> <p>14 Is that a fair description of what you</p> <p>15 did in this case?</p> <p>16 MR. FROST: Objection to form.</p> <p>17 THE WITNESS: I mean, I think the</p> <p>18 description of what I did is what I just outlined</p> <p>19 in the prior question. I mean, it's true I did</p> <p>20 not sample the -- the talc -- rocks from the talc</p> <p>21 mines, but again, I mean, as I've been describing,</p> <p>22 when I go out into the field, those objectives</p> <p>23 are -- are really driven by what I understand from</p> <p>24 the -- in this -- like in the case of Vermont, the</p> <p>25 decades of work of geologists and petrologists</p>	<p style="text-align: right;">Page 129</p> <p>1 the Vermont talc mines that we're interested in</p> <p>2 are in a pretty specific zone around mantling that</p> <p>3 Chester dome, and so bracketing that history</p> <p>4 are -- is work done -- I mean, really the most</p> <p>5 detailed study out there is that Sanford 1982</p> <p>6 paper, and Sanford sampled from, I think, three</p> <p>7 different locations in Vermont and also in</p> <p>8 Massachusetts. But in his study, he had samples</p> <p>9 from the Newfane mine and the Grafton mine, which</p> <p>10 basically bracket in PT space the -- the Argonaut,</p> <p>11 Hamm and Hammondsville mines, and so I was able to</p> <p>12 look at pretty gory detail in his -- in his paper.</p> <p>13 I was able also to compare that with</p> <p>14 the -- the Pooley study, who sampled different</p> <p>15 rock types around the mine, which, again, was of</p> <p>16 interest to me because I like to work with rock</p> <p>17 systems. And he had detailed petrographic data</p> <p>18 and descriptions in there, again photomicrographs,</p> <p>19 the kind of -- the kind of data that I regularly</p> <p>20 work with.</p> <p>21 And basically -- and also there was the</p> <p>22 Robinson -- or, sorry, the Robinson study from the</p> <p>23 Frostbite mine. And so, I mean, I feel like these</p> <p>24 rock bodies are -- are pretty tightly bracketed by</p> <p>25 these studies, and -- and I felt like I saw the</p>

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<p style="text-align: right;">Page 130</p> <p>1 information I needed in those works. 2 BY MR. BURNS: 3 Q So we're sitting here today in 4 Burlington, Vermont. How far approximately is the 5 Argonaut mine from here? 6 A Oh, I guess two-and-a-half hours or so. 7 Q Driving by car? 8 A Yeah, driving. 9 Q Okay. And you realize that the -- the 10 allegations in this case center in part on the 11 plaintiffs' allegations that asbestos was a 12 constituent mineral in the rocks that were mined 13 at the Argonaut mine. Is that correct? 14 MR. FROST: Objection to form. 15 THE WITNESS: I'm sorry, can you repeat 16 the -- 17 BY MR. BURNS: 18 Q Sure. Just asking you, you realize that 19 the allegations in this case center in part on 20 claims that asbestos was a constituent of the 21 material that was mined at Argonaut. 22 A Yeah. 23 Q Okay. Did you ever ask to go to the 24 Argonaut mine? 25 A No.</p>	<p style="text-align: right;">Page 132</p> <p>1 understanding, although you should correct me if I 2 don't, about this methodology you just described. 3 But I want to make sure that we capture and 4 exclude some -- some areas that I don't think fit 5 into it. 6 MR. BURNS: Oh, did I -- yeah, those are 7 two pages. Here. 8 BY MR. BURNS: 9 Q So I'm just going to ask you some 10 questions, and I will -- I'll mark this so I can 11 remember the answers. 12 So, Dr. Webb, have you ever worked in a 13 talc mine? 14 A No. 15 Q Have you ever designed any talc mine 16 operations? 17 A No. 18 Q Have you ever consulted on any talc mine 19 operations? 20 A No. 21 Q Have you ever designed any drill core 22 sampling protocols for talc mines? 23 A No. 24 Q Have you ever designed a blast hole 25 sampling protocol for a talc mine?</p>
<p style="text-align: right;">Page 131</p> <p>1 Q Were you ever told that you couldn't go 2 to the Argonaut mine? 3 A No. 4 Q And is that true of the other two J&J 5 mines in Vermont? 6 MR. FROST: Objection to form. 7 THE WITNESS: Yeah, I mean Hammondsville 8 is -- is underwater. It's a pond. So -- and I'm 9 not sure about the Hamm. I think, you know, 10 underground mining wouldn't -- or shafts wouldn't 11 be able. 12 But, yeah, no, I didn't ask to go. I 13 wasn't told that I should go or couldn't go. I 14 was left to use my professional opinion about how 15 that played out. 16 BY MR. BURNS: 17 Q I'm going to put up on the screen what 18 I've marked as Plaintiffs' Demonstrative No. 2. I 19 will give you and your counsel a copy of it, 20 though, just so you can follow along. 21 (Webb Exhibit No. 18 was 22 subsequently marked for 23 identification.) 24 BY MR. BURNS: 25 Q I think I have a pretty good</p>	<p style="text-align: right;">Page 133</p> <p>1 A No. 2 Q Have you ever designed an open pit 3 mining operation? 4 A No. 5 Q Ever designed an underground mining 6 operation? 7 A No. 8 Q Have you ever supervised or consulted on 9 the ongoing operation of a mine? 10 A No. 11 Q And I think I -- I think you've answered 12 this, but have you ever visited any of the J&J 13 talc mines in Vermont? 14 A No. 15 Q Is that also true of China and Italy? 16 A That's correct. 17 Q Have you ever conducted any field 18 observations at any talc mines? 19 A No. 20 Q Have you ever conducted any field 21 observations at any of the J&J talc mines? 22 A No. 23 Q Have you ever inspected any talc mines? 24 A No. 25 Q Or any J&J talc mines?</p>

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<p style="text-align: right;">Page 134</p> <p>1 A No.</p> <p>2 Q Have you ever reviewed any petrographic</p> <p>3 maps from J&J talc mines?</p> <p>4 A What do you mean by "petrographic maps"?</p> <p>5 Q Well, similar to some of the maps that</p> <p>6 you included in your report but specific to in</p> <p>7 Vermont, Italy or Chinese mines?</p> <p>8 A I mean, do you mean geologic maps?</p> <p>9 Because "petrographic" generally means</p> <p>10 observations made through a petrographic</p> <p>11 microscope. So petrographic maps to me would mean</p> <p>12 a map of a thin section.</p> <p>13 Q I see. So that doesn't make a whole</p> <p>14 hell of a lot of sense.</p> <p>15 A No.</p> <p>16 Q All right. Fair enough. Well, I tell</p> <p>17 you what, we will scratch that one.</p> <p>18 Have you ever reviewed any geologic</p> <p>19 map -- maps from a talc mine?</p> <p>20 A Yes.</p> <p>21 Q And what mine was that?</p> <p>22 A There was -- in the Robinson, et al.,</p> <p>23 2006, report from the Frostbite mine.</p> <p>24 Q Mm-hmm. Okay. How about any geologic</p> <p>25 maps from J&J talc mines?</p>	<p style="text-align: right;">Page 136</p> <p>1 Q Same question with respect to J&J talc</p> <p>2 mines.</p> <p>3 A Yes, that's --</p> <p>4 Q Same answer?</p> <p>5 A Yeah, yeah.</p> <p>6 Q Have you ever inspected any core logs</p> <p>7 from a talc mine?</p> <p>8 A No.</p> <p>9 Q Ever inspected any core logs from the</p> <p>10 J&J talc mines?</p> <p>11 A No.</p> <p>12 Q Ever asked for any samples of J&J talc</p> <p>13 from the --</p> <p>14 A No.</p> <p>15 Q -- products in question?</p> <p>16 A No.</p> <p>17 Q I'm sorry. And that answer was "no"?</p> <p>18 A Yes. Never asked for.</p> <p>19 Q Okay. Have you ever taken any samples</p> <p>20 or rock specimens from a talc mine?</p> <p>21 A No.</p> <p>22 Q Or from the J&J mines in question?</p> <p>23 A No.</p> <p>24 Q Have you ever conducted any XRD on any</p> <p>25 J&J talc?</p>
<p style="text-align: right;">Page 135</p> <p>1 A No.</p> <p>2 Q Did you ask whether any were available?</p> <p>3 A I didn't ask, no.</p> <p>4 Q Okay. Ever review any mine planning</p> <p>5 maps from a talc mine?</p> <p>6 A No.</p> <p>7 Q Have you ever reviewed drill cores taken</p> <p>8 from a talc mine?</p> <p>9 A No.</p> <p>10 Q Have you ever seen the drill cores taken</p> <p>11 from any of the J&J mines at issue here?</p> <p>12 A No.</p> <p>13 Q Have you ever reviewed any mine planning</p> <p>14 maps from the J&J talc mines?</p> <p>15 A No.</p> <p>16 Q Ever analyzed any thin sections from</p> <p>17 cores removed from a talc mine?</p> <p>18 A No.</p> <p>19 Q Same question with respect to J&J talc</p> <p>20 mines.</p> <p>21 A Yeah, no.</p> <p>22 Q Have you ever seen the results of any</p> <p>23 analysis of thin sections from cores removed from</p> <p>24 a talc mine?</p> <p>25 A From cores, no.</p>	<p style="text-align: right;">Page 137</p> <p>1 A No.</p> <p>2 Q What about PLM? We just talked about</p> <p>3 PLM a few minutes ago. Have you ever done that on</p> <p>4 any J&J talc?</p> <p>5 A No, personally I have not conducted</p> <p>6 those studies.</p> <p>7 Q Are you aware of any outside this</p> <p>8 litigation?</p> <p>9 A Sorry, then we're on -- specifically on</p> <p>10 J&J talc?</p> <p>11 Q Yes.</p> <p>12 A And this is the bodies that are being</p> <p>13 mined for the cosmetic talc?</p> <p>14 Q Yes.</p> <p>15 A No.</p> <p>16 Q Have you ever conducted any scanning</p> <p>17 electron microscopy on any talc?</p> <p>18 A I've seen it, yeah.</p> <p>19 Q Seen it, but have you conducted it</p> <p>20 yourself?</p> <p>21 A Well, yes. I mean, again, not on the</p> <p>22 talc ores that we're -- we're discussing, but I've</p> <p>23 seen talc in rocks on the SEM while I've been --</p> <p>24 Q So in other rocks.</p> <p>25 A Yes.</p>

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<p>1 Q But not with respect to any J&J talc.</p> <p>2 A No.</p> <p>3 Q Have you ever conducted any transmission</p> <p>4 electron microscopy on any talc samples?</p> <p>5 A No.</p> <p>6 Q And that would be true of J&J talc</p> <p>7 samples?</p> <p>8 A That's correct.</p> <p>9 Q Have you ever seen test results from</p> <p>10 samples taken from the J&J talc mines?</p> <p>11 A Test -- what kind of test results?</p> <p>12 Q Test results with respect to asbestos or</p> <p>13 other contaminants.</p> <p>14 A No.</p> <p>15 Q Have you ever designed or supervised a</p> <p>16 beneficiation process for talc ore?</p> <p>17 A No.</p> <p>18 Q Have you ever published on talc deposits</p> <p>19 used to source J&J talc in Italy, Vermont or</p> <p>20 China?</p> <p>21 A No.</p> <p>22 Q And I think you answered this earlier,</p> <p>23 you've never published on asbestiform amphiboles</p> <p>24 in talc, have you?</p> <p>25 A No.</p>	<p>1 phone, I think.</p> <p>2 Q Okay. And what was that about?</p> <p>3 A I was curious where I could access some</p> <p>4 of her data on some of the -- the studies she's</p> <p>5 compiled or done, so the WebLink distributions,</p> <p>6 et cetera.</p> <p>7 Q Anything else in that conversation?</p> <p>8 A No.</p> <p>9 Q And was that the only conversation</p> <p>10 you've had with her?</p> <p>11 A That's the only time I've spoken with</p> <p>12 Ann Wylie.</p> <p>13 Q And was that in the context of</p> <p>14 discussions about asbestos, the conversation you</p> <p>15 had with her?</p> <p>16 A Yeah, so the -- I was looking for the --</p> <p>17 the data from both known -- you know, like the --</p> <p>18 the standards -- known asbestos versus known</p> <p>19 cleavage fragments.</p> <p>20 Q Did Dr. Wylie inform you that she was</p> <p>21 serving as an expert witness in this litigation?</p> <p>22 MR. FROST: Objection to form.</p> <p>23 THE WITNESS: It was prior to this, so</p> <p>24 neither of us knew.</p> <p>25 BY MR. BURNS:</p>
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<p>1 Q And is that also true of asbestiform</p> <p>2 serpentines?</p> <p>3 A No -- I mean, you're correct, and the</p> <p>4 answer is no.</p> <p>5 Q Have you ever published on</p> <p>6 methodological approaches to differentiate</p> <p>7 asbestiform amphiboles and non-amphibole minerals</p> <p>8 in talc?</p> <p>9 A No.</p> <p>10 Q And have you ever personally identified</p> <p>11 any asbestiform amphiboles in talc?</p> <p>12 A No.</p> <p>13 Q All right. Thank you, Doctor.</p> <p>14 (Counsel conferring.)</p> <p>15 BY MR. BURNS:</p> <p>16 Q Now, recalling our discussion on your</p> <p>17 supplemental list earlier today, I noted that you</p> <p>18 had read the deposition and expert report of Ann</p> <p>19 Wylie.</p> <p>20 Have you ever discussed this case or</p> <p>21 your findings with Dr. Wylie?</p> <p>22 A No.</p> <p>23 Q Have you ever spoken to Dr. Wylie</p> <p>24 before?</p> <p>25 A Last summer, once I spoke to her on the</p>	<p>1 Q And you haven't spoken to her since your</p> <p>2 reports came out?</p> <p>3 A No.</p> <p>4 Q All right. I also noticed you had read</p> <p>5 the deposition and expert report of Mary Poulton,</p> <p>6 Dr. Mary Poulton.</p> <p>7 A Yes.</p> <p>8 Q Have you ever spoken to Dr. Poulton</p> <p>9 about asbestos in talc?</p> <p>10 A No.</p> <p>11 Q Any conversations with her whatsoever?</p> <p>12 A I've never met her or talked to her,</p> <p>13 yeah.</p> <p>14 Q And you also reviewed the expert report</p> <p>15 of Dr. Darby Dyar; is that right?</p> <p>16 A That's correct, yeah.</p> <p>17 Q And have you spoken with Dr. Dyar?</p> <p>18 A I met her in October of 2018, I believe,</p> <p>19 because she was invited to come give a seminar in</p> <p>20 our department.</p> <p>21 Q What was the seminar of?</p> <p>22 A It was related to her work on Mars, that</p> <p>23 program.</p> <p>24 Q Did you discuss anything with respect to</p> <p>25 asbestos or talc?</p>

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<p style="text-align: right;">Page 142</p> <p>1 A Not in great detail. I mean, I -- I</p> <p>2 took her to lunch, and we were having a</p> <p>3 conversation about the general paths of our -- our</p> <p>4 careers, and so we understood that we were both</p> <p>5 working with J&J lawyers. But, again, that was</p> <p>6 prior to this case, and we didn't go into any</p> <p>7 details.</p> <p>8 Q Any specific conversation about asbestos</p> <p>9 and the talc in J&J mines?</p> <p>10 A No.</p> <p>11 Q And going back to your conversation with</p> <p>12 Dr. Wylie, why were you interested in the data you</p> <p>13 were asking her about?</p> <p>14 A Because -- well -- yeah, so I was just</p> <p>15 doing general consulting, meaning I was doing some</p> <p>16 research to bolster my understanding of the topic,</p> <p>17 and, you know, occasionally I was asked to respond</p> <p>18 to a document or a paper. And so I had seen some</p> <p>19 of Dr. Longo's reports, and so there was an</p> <p>20 analysis that -- in one of his reports that</p> <p>21 related to the size distributions of -- of</p> <p>22 structures he was measuring with -- with the TEM.</p> <p>23 And so I was curious about that topic and wanted</p> <p>24 to explore it further on my own.</p> <p>25 Q And who provided you those reports?</p>	<p style="text-align: right;">Page 144</p> <p>1 again, looking at a data -- a large dataset, what</p> <p>2 were the --</p> <p>3 Q Okay. And did you reach any</p> <p>4 conclusions?</p> <p>5 MR. FROST: I was going to say --</p> <p>6 THE WITNESS: Yeah, this is --</p> <p>7 MR. FROST: -- I'm going to caution you</p> <p>8 to the extent that -- we're now reaching into</p> <p>9 consultancy, which has nothing to do with her work</p> <p>10 here.</p> <p>11 I'm just going to caution her, you know,</p> <p>12 obviously any communications you've had with</p> <p>13 lawyers during the consultancy and any work</p> <p>14 product that you created during the consultancy,</p> <p>15 I'm going to instruct you not to answer on that.</p> <p>16 But if it's something that you drew yourself, you</p> <p>17 know, sort of separately from what you were</p> <p>18 working with the lawyers on, you know, that you</p> <p>19 can answer.</p> <p>20 THE WITNESS: Pardon me. I have an</p> <p>21 eyelash attacking my eyeball.</p> <p>22 BY MR. BURNS:</p> <p>23 Q That's okay. Do you need to take a</p> <p>24 break or --</p> <p>25 A I'll be fine.</p>
<p style="text-align: right;">Page 143</p> <p>1 A Those would have come from Jonathan</p> <p>2 Cooper.</p> <p>3 Q And who's Mr. Cooper?</p> <p>4 A He's with Tucker & Ellis.</p> <p>5 Q So after receiving that data, what did</p> <p>6 you do?</p> <p>7 A I -- I basically -- I mean, with Ann's</p> <p>8 data or ultimately with the online datasets that</p> <p>9 they've published, I was able to bring that into</p> <p>10 Excel, and so I was exploring different methods of</p> <p>11 plotting the data, aspect ratio versus width or</p> <p>12 width versus lengths or, you know, the variety of</p> <p>13 ways, log, normal, just -- not -- excuse me.</p> <p>14 Pardon me. So, yes, it was sort of an exploration</p> <p>15 in plotting methods to see what seemed to be most</p> <p>16 meaningful.</p> <p>17 Q And what do you mean by "most</p> <p>18 meaningful"?</p> <p>19 A Well, I mean, in particular, looking at</p> <p>20 Ann's data, cleavage fragments versus known</p> <p>21 documented asbestos, seeing if there was a</p> <p>22 plotting method where you could see a clear</p> <p>23 distinction in populations.</p> <p>24 Q I see.</p> <p>25 A I mean, not in a single particle, but,</p>	<p style="text-align: right;">Page 145</p> <p>1 Yeah, I -- honestly, I haven't reviewed</p> <p>2 that in preparation for this. It's not part of</p> <p>3 the opinions I'm -- or I offered in my report. So</p> <p>4 I'd rather not comment on that without having</p> <p>5 refreshed my memory of those graphs.</p> <p>6 MS. O'DELL: If the data has been</p> <p>7 provided to Dr. Webb, we would request on the</p> <p>8 record that the data from Dr. Wylie be provided to</p> <p>9 us. I will formalize that request after the</p> <p>10 deposition, but I think we're entitled to it if</p> <p>11 she has reviewed it.</p> <p>12 MR. FROST: Again, I think she just said</p> <p>13 she didn't consider it as any part of this</p> <p>14 opinion, so I actually -- I will lodge an</p> <p>15 objection to that. And moreover, I think she</p> <p>16 testified that she had a link to online data</p> <p>17 sources that she looked at.</p> <p>18 So to the extent that you are</p> <p>19 insinuating she was provided data by Ann Wylie, I</p> <p>20 think that is other than what the record reflects</p> <p>21 here.</p> <p>22 MS. O'DELL: I think the record is quite</p> <p>23 clear, and regardless of that, it was not</p> <p>24 disclosed --</p> <p>25 MR. FROST: And --</p>

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<p style="text-align: right;">Page 146</p> <p>1 MS. O'DELL: And if it's available</p> <p>2 publicly, that's one thing, but we have to know</p> <p>3 that she's been provided that data. And so we</p> <p>4 would request that it be --</p> <p>5 MR. FROST: And I guess I'm just failing</p> <p>6 to understand why we would have to produce you</p> <p>7 data that has obviously nothing to do with this</p> <p>8 engagement. You can send a letter, but, you know,</p> <p>9 obviously we object to it.</p> <p>10 MS. O'DELL: We will let the court</p> <p>11 decide about that.</p> <p>12 MR. FROST: That's fine.</p> <p>13 But again, I think she's made it very</p> <p>14 clear this has absolutely nothing to do with what</p> <p>15 she's been engaged to do.</p> <p>16 MS. O'DELL: Please don't coach the</p> <p>17 witness.</p> <p>18 MR. FROST: Please don't what?</p> <p>19 THE REPORTER: I couldn't hear you.</p> <p>20 MS. O'DELL: Please don't coach the</p> <p>21 witness.</p> <p>22 MR. FROST: I'm not coaching at all.</p> <p>23 I'm responding to your statement on the record.</p> <p>24 BY MR. BURNS:</p> <p>25 Q What was -- what was the form of the</p>	<p style="text-align: right;">Page 148</p> <p>1 A I'm familiar with the name, but I've</p> <p>2 never met or talked or communicated with her.</p> <p>3 Q You mentioned Mickey Gunter earlier?</p> <p>4 A Yes.</p> <p>5 Q Is that right?</p> <p>6 What is your relationship with Mickey</p> <p>7 Gunter?</p> <p>8 A Well, shortly after I came to UVM, he</p> <p>9 had a -- a Marsh Fellowship, I think is what they</p> <p>10 call it, but it's basically an honorary visiting</p> <p>11 professorship. So he's -- it might have been</p> <p>12 2009, around that time, that he was in our</p> <p>13 department maybe for a couple of weeks at a time</p> <p>14 throughout the -- the year. So that's when I met</p> <p>15 him.</p> <p>16 Q I see. And have you continued a</p> <p>17 friendship or professional relationship with him</p> <p>18 since?</p> <p>19 A I haven't talked to him since that March</p> <p>20 Fellowship, so not in eight years or something</p> <p>21 like that or -- yeah.</p> <p>22 Q Have you communicated with him by e-mail</p> <p>23 or any other means?</p> <p>24 A No.</p> <p>25 Q No. Dr. Webb, I think we can mark off</p>
<p style="text-align: right;">Page 147</p> <p>1 Longo reports that you had at the time?</p> <p>2 MR. FROST: Objection to form.</p> <p>3 THE WITNESS: The form of the Longo -- I</p> <p>4 mean, they were PDF documents that kind of</p> <p>5 mimicked the format of -- of this. So...</p> <p>6 BY MR. BURNS:</p> <p>7 Q And this was the summer of 2018?</p> <p>8 A I would have to -- that's a -- I mean,</p> <p>9 my best guess for the general time frame, but I</p> <p>10 don't remember details.</p> <p>11 Q And do you recall whether they were</p> <p>12 taken from litigation or --</p> <p>13 A Oh, they were -- yeah. I mean, they</p> <p>14 were expert reports, so...</p> <p>15 Q Okay. Do you know Dr. Brooke Mossman?</p> <p>16 A I've met her once, yeah, or twice now.</p> <p>17 I ran into her in the parking lot. So...</p> <p>18 Q Have you had any conversations with her</p> <p>19 about this case?</p> <p>20 A No.</p> <p>21 Q Have you had any conversations with her</p> <p>22 about asbestos in talc?</p> <p>23 A No, not specifically.</p> <p>24 Q Do you know a Dr. Shukla, I think in her</p> <p>25 department?</p>	<p style="text-align: right;">Page 149</p> <p>1 preparation.</p> <p>2 A Very good.</p> <p>3 Q One left.</p> <p>4 MR. BURNS: Should we take a short</p> <p>5 break?</p> <p>6 THE WITNESS: Yeah. Fill my water</p> <p>7 glass.</p> <p>8 THE VIDEOGRAPHER: Going off the record</p> <p>9 at 2:42 p.m.</p> <p>10 (Recess.)</p> <p>11 THE VIDEOGRAPHER: We're back on the</p> <p>12 record at 3:10 p.m.</p> <p>13 BY MR. BURNS:</p> <p>14 Q Welcome back, Dr. Webb.</p> <p>15 Dr. Webb, were you aware that -- that</p> <p>16 Dr. Mickey Gunter serves as an expert witness for</p> <p>17 J&J?</p> <p>18 A I am aware of that, yes.</p> <p>19 Q How did you become aware of it?</p> <p>20 A I mean, I knew in general of his</p> <p>21 involvement as an expert witness from when he</p> <p>22 visited UVM long ago, but -- I suppose like the</p> <p>23 details of his working for J&J came out sometime</p> <p>24 during the consulting. I mean, seeing documents,</p> <p>25 et cetera.</p>

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<p style="text-align: right;">Page 150</p> <p>1 Q All right. Dr. Webb, at long last we've</p> <p>2 made it to the report section.</p> <p>3 MR. BURNS: Are you okay?</p> <p>4 MR. FROST: Yeah. I just kicked the</p> <p>5 table pretty hard.</p> <p>6 MR. BURNS: That's no fun.</p> <p>7 BY MR. BURNS:</p> <p>8 Q So I'd like to direct you to, I believe,</p> <p>9 Exhibit 1. And is this a true and correct copy of</p> <p>10 your expert report?</p> <p>11 A It appears so, yes.</p> <p>12 Q All right. And did you prepare this</p> <p>13 report yourself?</p> <p>14 A I did, yes.</p> <p>15 Q Did you write every word of it?</p> <p>16 A I did, yes.</p> <p>17 Q Now, one of the terms that appears</p> <p>18 throughout your report -- and we'll get to the</p> <p>19 certain instances of it, but we've also -- I've</p> <p>20 also heard you mention it today -- is you've</p> <p>21 emphasized, I believe you call it, high purity</p> <p>22 talc or cosmetic grade talc deposits.</p> <p>23 A (The witness nods.)</p> <p>24 Q Can you explain what you mean when</p> <p>25 you're using that term?</p>	<p style="text-align: right;">Page 152</p> <p>1 Italy and China.</p> <p>2 Q Mm-hmm. Would it be fair to say then</p> <p>3 that that high purity grade of talc deposit is one</p> <p>4 that is, for lack of a better term, pure enough to</p> <p>5 attract the interest of industrial or cosmetic</p> <p>6 purposes?</p> <p>7 MR. FROST: Objection to form.</p> <p>8 THE WITNESS: Yeah, I mean, they</p> <p>9 wouldn't be interested in something that wasn't</p> <p>10 rich in talc and, yeah, relatively high purity.</p> <p>11 BY MR. BURNS:</p> <p>12 Q So let's say you had a deposit where for</p> <p>13 every pound of talc you extracted, there was</p> <p>14 another pound of waste. Would that fall into that</p> <p>15 category for you?</p> <p>16 MR. FROST: Objection to form.</p> <p>17 THE WITNESS: Yeah, I don't know. I</p> <p>18 mean, that kind of gets beyond my area of -- of</p> <p>19 expertise and distinction, I think. Because,</p> <p>20 yeah, I'm not an expert in the mining process,</p> <p>21 and --</p> <p>22 That eyelash came back. Sorry.</p> <p>23 BY MR. BURNS:</p> <p>24 Q Sure. Oh, no.</p> <p>25 I guess another way to look at it -- and</p>
<p style="text-align: right;">Page 151</p> <p>1 A Well, I -- I guess I'm making the</p> <p>2 distinction between a rock that has talc in it or</p> <p>3 a rock that may have abundant talc in it versus</p> <p>4 something that is talc rich enough that it would</p> <p>5 be of interest for the mining companies.</p> <p>6 Q And is that really the trigger whether</p> <p>7 it's -- whether industrial use -- it's capable of</p> <p>8 industrial use or extraction?</p> <p>9 MR. FROST: Objection to form.</p> <p>10 BY MR. BURNS:</p> <p>11 Q I don't want to put words in your mouth.</p> <p>12 A Yeah.</p> <p>13 Q I'm just really trying to tease out what</p> <p>14 you mean by that.</p> <p>15 A Well, I mean, I think there are</p> <p>16 definitions for "cosmetic grade talc," and I know</p> <p>17 that it reflects -- maybe after a beneficiation,</p> <p>18 the purity levels that are -- you're able to</p> <p>19 attain coupled with some other geochemical</p> <p>20 requirements and in the absence of asbestos.</p> <p>21 But I think, you know, one of the</p> <p>22 distinctions I'm trying to make is a rock that has</p> <p>23 talc in it versus something that has undergone</p> <p>24 such extreme degrees of metasomatism that we</p> <p>25 arrive at the deposits that we have in Vermont and</p>	<p style="text-align: right;">Page 153</p> <p>1 really, again, I'm just trying to understand --</p> <p>2 but for this purpose, the only mines you were</p> <p>3 looking at were in your view high purity deposits</p> <p>4 because they were used as mines for the talc</p> <p>5 industry. Is that fair?</p> <p>6 MR. FROST: Objection to form.</p> <p>7 THE WITNESS: Well, I mean, they're --</p> <p>8 so obviously it boils down to my opinion about the</p> <p>9 mines that were used for the talc that was used in</p> <p>10 talcum powders, and -- but I was actually looking</p> <p>11 at a larger body of literature to kind of</p> <p>12 understand the systems and -- and sort of bracket</p> <p>13 again these conditions where these rocks formed.</p> <p>14 BY MR. BURNS:</p> <p>15 Q Just to be sure that I don't miss it</p> <p>16 if there is a distinction, the J&J talc mines --</p> <p>17 what we've been referring to as the J&J talc mines</p> <p>18 are all in view -- in your view, high purity</p> <p>19 deposits; is that right?</p> <p>20 A Well, yes. Deposits from which cosmetic</p> <p>21 grade talc can be derived.</p> <p>22 Q Okay. And so we've talked about those</p> <p>23 three mines in Vermont. We've also mentioned some</p> <p>24 other mines around there, the Johnson mine,</p> <p>25 Rainbow mine. Would you consider those high</p>

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<p style="text-align: right;">Page 154</p> <p>1 purity talc deposits as well?</p> <p>2 MR. FROST: Objection to form.</p> <p>3 THE WITNESS: Yeah. I mean, there may</p> <p>4 be zones of -- you know, so even the Newfane mine</p> <p>5 has high purity talc zone in it, but the Newfane</p> <p>6 mine, that zone is so thin, I think it wasn't</p> <p>7 economically viable. So it could include mines</p> <p>8 from which there is no active or was no active</p> <p>9 mining based on the economic viability of it.</p> <p>10 BY MR. BURNS:</p> <p>11 Q Okay. So I would like you to turn to</p> <p>12 page 1 of your report, which contains the</p> <p>13 executive summary.</p> <p>14 A Okay.</p> <p>15 Q So as its title indicates, I take it</p> <p>16 this section summarizes your opinions that you are</p> <p>17 prepared to testify to in this litigation.</p> <p>18 A Yes. An overview of them, yes.</p> <p>19 Q Okay. I'd like to start with</p> <p>20 subparagraph A in Section 1.0 of the executive</p> <p>21 summary.</p> <p>22 So subparagraph A begins with the</p> <p>23 statement: "Plaintiffs' experts' reports fail to</p> <p>24 appropriately synthesize key data and observations</p> <p>25 available in the peer-reviewed scientific</p>	<p style="text-align: right;">Page 156</p> <p>1 report today?</p> <p>2 MR. FROST: Objection to form. Outside</p> <p>3 of the scope of this witness's opinions.</p> <p>4 THE WITNESS: Can -- can I answer or --</p> <p>5 MR. FROST: Yes.</p> <p>6 THE WITNESS: Sorry.</p> <p>7 MR. FROST: Unless I specifically</p> <p>8 instruct you not to answer, you can answer.</p> <p>9 THE WITNESS: Okay. I mean, yeah, my</p> <p>10 experience -- for example, anthophyllite and talc</p> <p>11 have very similar geochemistry -- or, sorry,</p> <p>12 chemistries that, in general, EDS is not</p> <p>13 sufficient to distinguish the two. And -- and he</p> <p>14 never provided quantitative data based on the EDS</p> <p>15 analyses, and so, you know, there are -- are</p> <p>16 issues there that I -- I take issue with.</p> <p>17 I would also say that I'm not an expert</p> <p>18 in SAED, so I'm not going to go down that road at</p> <p>19 all.</p> <p>20 Some things that are shown in the TEM</p> <p>21 images look much more like cleavage fragments to</p> <p>22 me than asbestos fibrils or bundles, but -- but I</p> <p>23 guess -- so it's my general reaction to the use of</p> <p>24 the EDS data, and -- yeah, and the -- and the</p> <p>25 assertion that some of these amphiboles that</p>
<p style="text-align: right;">Page 155</p> <p>1 literature that are pertinent to understanding the</p> <p>2 issues in this litigation."</p> <p>3 Did I read that correctly?</p> <p>4 A Yes.</p> <p>5 Q Okay. What -- first of all, what</p> <p>6 plaintiffs' experts' reports are you referencing</p> <p>7 there? Is it Dr. Cook and Dr. Krekeler?</p> <p>8 A Correct.</p> <p>9 Q Okay. Any others?</p> <p>10 A No.</p> <p>11 Q Okay. It's not Dr. Longo?</p> <p>12 A No.</p> <p>13 Q Do you have any opinions with respect to</p> <p>14 Dr. Longo's work?</p> <p>15 A Not that I'm offering in this report or</p> <p>16 today, no.</p> <p>17 Q Have you -- do you intend to offer</p> <p>18 opinions with respect to Dr. Longo in the future?</p> <p>19 MR. FROST: Objection to form.</p> <p>20 THE WITNESS: I mean, I think it depends</p> <p>21 on the questions that are -- are asked. But that</p> <p>22 really wasn't my charge to respond to his report,</p> <p>23 and so, yes, I did read it, but --</p> <p>24 BY MR. BURNS:</p> <p>25 Q Do you have any criticism of Dr. Longo's</p>	<p style="text-align: right;">Page 157</p> <p>1 presumably are identified in there based on the</p> <p>2 other analyses are -- are asbestos.</p> <p>3 BY MR. BURNS:</p> <p>4 Q Okay. Anything else?</p> <p>5 A No.</p> <p>6 Q All right. You next say that Dr. Cook</p> <p>7 and Dr. Krekeler, the plaintiffs' experts you</p> <p>8 refer to, failed to appropriately synthesize key</p> <p>9 data.</p> <p>10 What data did you have -- do you have in</p> <p>11 mind there?</p> <p>12 A Well, I mean, the -- the details of the</p> <p>13 geology of Vermont, the details of the</p> <p>14 metamorphism recorded by the rocks in the region</p> <p>15 of -- of interest, they basically present broad</p> <p>16 generalizations from some of these papers that</p> <p>17 present generalizations, and, you know, try to</p> <p>18 make analogies between rocks in the southern</p> <p>19 Appalachians, and I think the mines in Vermont are</p> <p>20 a very different beast than the ultramafic bodies</p> <p>21 that are -- are elsewhere throughout the orogen.</p> <p>22 Q Okay. What about Italy and China?</p> <p>23 A Yeah, so with China, I didn't see them</p> <p>24 zeroing in on the -- the Guangxi mines that were</p> <p>25 actually used. There -- I know Krekeler, I think</p>

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<p style="text-align: right;">Page 158</p> <p>1 specifically more than Cook, at least what I</p> <p>2 remember offhand, is that, you know, a lot of his</p> <p>3 discussion included mines that were thousands of</p> <p>4 kilometers away off in the Shandong Peninsula that</p> <p>5 were totally irrelevant.</p> <p>6 So, again, it's the lack of detail</p> <p>7 related to petrological evolution in the immediate</p> <p>8 vicinity of -- of the mines from which the talc</p> <p>9 was derived.</p> <p>10 Q And you next question the observations</p> <p>11 available in the peer-reviewed scientific</p> <p>12 literature that are pertinent to understanding the</p> <p>13 issues in this litigation.</p> <p>14 Is your use of data and observations</p> <p>15 there somewhat synonymous, or are you drawing a</p> <p>16 distinction?</p> <p>17 A I mean, there -- yeah. I guess it's</p> <p>18 redundant in a sense.</p> <p>19 Q Not criticizing.</p> <p>20 A Yeah.</p> <p>21 Q Okay. Just trying to understand whether</p> <p>22 there is a unique distinction there.</p> <p>23 You reviewed, and I can't remember the</p> <p>24 precise number, quite a few articles and reports</p> <p>25 with respect to the geology of Vermont. Is that</p>	<p style="text-align: right;">Page 160</p> <p>1 forming, they see information that is very</p> <p>2 clearcut that they are not part of the same event.</p> <p>3 And that is, that the asbestos forms during</p> <p>4 late -- presumably in the tectonic orogeny when</p> <p>5 these rocks are at low temperatures, low</p> <p>6 pressures, they're -- these ultramafic bodies,</p> <p>7 which were, you know, basically the rock collage</p> <p>8 when it was kind of assembled at that time for a</p> <p>9 large part, especially the bodies where the</p> <p>10 asbestos is documented.</p> <p>11 So in the late stages of the tectonic</p> <p>12 orogeny about 450 million years ago, that's when</p> <p>13 these ultramafic rocks are forming brittle</p> <p>14 fractures. Water rich fluids are interacting with</p> <p>15 them. Serpentinization is occurring. And that is</p> <p>16 when the chrysotile asbestos forms. And the few</p> <p>17 instances that are documented of tremolite</p> <p>18 asbestos are also part of that same event.</p> <p>19 Now, the talc, as I said before, forms</p> <p>20 during the Acadian orogeny, so that's 80, 90</p> <p>21 million years later, under very different</p> <p>22 conditions. And I would also say that the rocks</p> <p>23 from which the -- the cosmetic talc is derived in</p> <p>24 Vermont is in a different geologic belt than the</p> <p>25 asbestos-bearing rocks.</p>
<p style="text-align: right;">Page 159</p> <p>1 fair?</p> <p>2 A Yes.</p> <p>3 Q Okay. Do any of those reports stand out</p> <p>4 to you as particularly sound in terms of their</p> <p>5 methodology, their primary sourcing, et cetera?</p> <p>6 MR. FROST: Objection to form.</p> <p>7 THE WITNESS: Particularly sound? Well,</p> <p>8 certainly, as I mentioned before, the Sanford 1982</p> <p>9 article really is the -- the piece of literature</p> <p>10 out there that looked into the systems in which</p> <p>11 talc is forming in -- in these rocks. You know,</p> <p>12 it's really, again, kind of putting together the</p> <p>13 body of data.</p> <p>14 But I will say Chidester comes up.</p> <p>15 There -- there are a number of -- of articles that</p> <p>16 make this same statement, and this is what I think</p> <p>17 is key, is that -- again, there's a polyphase</p> <p>18 tectonic history. So we've got three big orogenic</p> <p>19 events that kind of build up the geology in</p> <p>20 Vermont and influence it.</p> <p>21 And the people who have looked at those</p> <p>22 rocks -- so Chidester said it, Sanford said it --</p> <p>23 those are the two that really come to mind -- is</p> <p>24 that when they look at the relationship between</p> <p>25 where asbestos is formed and where the talc is</p>	<p style="text-align: right;">Page 161</p> <p>1 But in any case, if -- you know, so</p> <p>2 the -- the Acadian orogeny event where the talc is</p> <p>3 forming is at much higher temperature conditions.</p> <p>4 The rocks are deforming ductilely. There's this</p> <p>5 intense metasomatism that's going on, and that is</p> <p>6 the diffusion of chemical elements across these</p> <p>7 rock boundaries that is basically changing the</p> <p>8 composition of the ultramafic rock to something</p> <p>9 that's much closer to the talc composition.</p> <p>10 That's why I have those weird triangle</p> <p>11 diagrams in my report to demonstrate that. Sorry,</p> <p>12 they're not weird to me, but I know they're odd to</p> <p>13 others, a non-petrologist. I'll clarify that.</p> <p>14 And so we really have, again, a</p> <p>15 different set of conditions. The fluids are water</p> <p>16 and carbon dioxide rich in the Acadian orogeny.</p> <p>17 And, again, there's no asbestos as far as I've</p> <p>18 been able to determine that are recorded in those</p> <p>19 rocks in any clearcut fashion, but, say, had</p> <p>20 chrysotile been present in the ultramafic bodies</p> <p>21 from which the talc formed, it would have been</p> <p>22 erased by that -- that metamorphic process.</p> <p>23 So this is why I say I don't see any</p> <p>24 documentation of it, nor were the conditions</p> <p>25 appropriate. Because, again, where it's been</p>

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<p style="text-align: right;">Page 162</p> <p>1 documented, it's -- asbestos is forming under --</p> <p>2 in different places in space and time and under</p> <p>3 different conditions than the -- than the talc</p> <p>4 forms.</p> <p>5 BY MR. BURNS:</p> <p>6 Q Okay. So just to be clear, it's your</p> <p>7 opinion that you've not seen any evidence of</p> <p>8 asbestos in the J&J talc mines that we have been</p> <p>9 discussing, right?</p> <p>10 A That's correct.</p> <p>11 Q Okay. Is it your opinion that there is</p> <p>12 no evidence of asbestos in those J&J talc mines?</p> <p>13 MR. FROST: Objection to form.</p> <p>14 THE WITNESS: It's not been</p> <p>15 demonstrated to -- no evidence has been</p> <p>16 demonstrated to me in the -- in the literature or</p> <p>17 the reports that I've reviewed.</p> <p>18 BY MR. BURNS:</p> <p>19 Q Okay. Let me ask you a follow-on</p> <p>20 question then.</p> <p>21 Is it your professional opinion that it</p> <p>22 is impossible for asbestos to exist in the talc</p> <p>23 sourced from the J&J talc mines?</p> <p>24 MR. FROST: Objection to form.</p> <p>25 THE WITNESS: It's extremely unlikely.</p>	<p style="text-align: right;">Page 164</p> <p>1 descriptions. Again, I wasn't looking at the</p> <p>2 finished products. So I don't want to offer</p> <p>3 opinions on those, but --</p> <p>4 BY MR. BURNS:</p> <p>5 Q You mean you haven't actually seen the</p> <p>6 thin sections. You're -- you've read descriptions</p> <p>7 of them in the findings. Is that what you're</p> <p>8 saying?</p> <p>9 MR. FROST: Objection to form.</p> <p>10 THE WITNESS: In the literature and</p> <p>11 reports that I reviewed, that's what I'm</p> <p>12 summarizing, yes.</p> <p>13 BY MR. BURNS:</p> <p>14 Q Do you have any opinion as to the -- as</p> <p>15 to whether the appearance of fibrous talc would be</p> <p>16 common in the talc sourced from the J&J mines?</p> <p>17 MR. FROST: Objection to form.</p> <p>18 THE WITNESS: It could be present.</p> <p>19 BY MR. BURNS:</p> <p>20 Q In sub- -- in substantial quantities?</p> <p>21 MR. FROST: Objection to form.</p> <p>22 THE WITNESS: I have no -- I mean, I</p> <p>23 think they are principally -- my understanding is</p> <p>24 they are principally looking for platy talc, but,</p> <p>25 you know, so in rock bodies dominated by that, you</p>
<p style="text-align: right;">Page 163</p> <p>1 BY MR. BURNS:</p> <p>2 Q But not impossible?</p> <p>3 MR. FROST: Objection to form.</p> <p>4 THE WITNESS: Geologists don't like</p> <p>5 using the word "impossible," but I would be</p> <p>6 extremely surprised.</p> <p>7 BY MR. BURNS:</p> <p>8 Q Can you in your professional opinion</p> <p>9 imagine circumstances where the chrysotile or</p> <p>10 tremolite asbestos made its way into talc deposits</p> <p>11 and was not erased by that process you were</p> <p>12 describing?</p> <p>13 MR. FROST: Objection to form.</p> <p>14 THE WITNESS: Not in the local geology.</p> <p>15 BY MR. BURNS:</p> <p>16 Q Not in Vermont.</p> <p>17 A Not -- yeah.</p> <p>18 Q How about -- and, again, focusing on</p> <p>19 Vermont here. We'll get back to China and Italy.</p> <p>20 So focusing on Vermont, have you seen</p> <p>21 evidence of fibrous talc in the talc that was</p> <p>22 sourced from the J&J mines?</p> <p>23 MR. FROST: Objection to form.</p> <p>24 THE WITNESS: I've seen evidence of</p> <p>25 fibrous talc recorded in the thin section</p>	<p style="text-align: right;">Page 165</p> <p>1 can't rule out the -- the local presence of a</p> <p>2 fibrous talc.</p> <p>3 BY MR. BURNS:</p> <p>4 Q So it could be present.</p> <p>5 A Yes. I mean, we know it forms from</p> <p>6 often -- I mean, a fibrous morphology again is the</p> <p>7 result of the way the metamorphic reaction</p> <p>8 proceeded, so those reactions are documented in</p> <p>9 these rocks. So, yes.</p> <p>10 Q Let's focus on China for a moment and</p> <p>11 the Guangxi mines. What is your -- is your</p> <p>12 opinion the same with respect to those mines as it</p> <p>13 is with the Vermont J&J mines?</p> <p>14 A Yeah. I mean, they formed in a</p> <p>15 different bulk composition and a different system,</p> <p>16 but at similar metamorphic grades and with similar</p> <p>17 principles at play. And once again, I never saw</p> <p>18 anything in the literature related to the local</p> <p>19 geology around those mines to support an assertion</p> <p>20 of the presence of asbestos.</p> <p>21 Q Did you see anything in the literature</p> <p>22 related to the local geology of those mines?</p> <p>23 A Yes.</p> <p>24 Q What was that?</p> <p>25 A Well, so -- I mean, I cite the papers</p>

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<p style="text-align: right;">Page 166</p> <p>1 that I -- I looked at. But basically that region 2 is -- is described in some detail in studies of -- 3 and people who were again looking at the tectonic 4 evolution of the rocks, but -- say Yao, et al., 5 2016, which is where the map figure is derived, 6 the Guangxi mine plots within that -- that mapped 7 area, and the formation of talc in those units is 8 described in the literature. 9 Lee, 1979, actually documents that in 10 detail and explores the -- the metamorphic 11 reactions involved in generating the -- the talc. 12 So, yes, there is -- there are 13 descriptions of the local geology in -- of the 14 units that are bracketing the talc bodies and from 15 which the talc was derived or formed. 16 Q But none of those are specific to the 17 Guangxi mine; is that right? 18 MR. FROST: Objection to form. 19 THE WITNESS: Oh, well, I mean it is 20 specific to them. This is the area that the -- 21 the mines are located. It relates to the units 22 that are documented in the -- the IMS documents 23 that describe the mines. So... 24 BY MR. BURNS: 25 Q I guess I -- maybe I did not phrase that</p>	<p style="text-align: right;">Page 168</p> <p>1 different when you're talking about the -- the 2 genesis of the talc itself. 3 Q What was the nature of the underlying 4 rock? Was it ultramafic or chloritic? 5 MR. FROST: Objection to form. Where? 6 BY MR. BURNS: 7 Q In China. 8 A Yeah. So, again, dolomitic marbles 9 juxtaposed next to these mafic igneous rocks that 10 underwent greenschist facies metamorphism. So, 11 again, that's in that range of, say, 500 -- around 12 500 degrees C. 13 So, yeah, in some of the mafic units, I 14 mean, there -- yeah, there's -- there's chlorite 15 present locally. They -- they don't describe the 16 same blackwall zones, and that's again because the 17 rock types are different. So... 18 Q And what is a blackwall zone? 19 A It refers -- well, so in -- in Vermont, 20 it refers to the -- the zone that's right at the 21 contact of the ultramafic rocks and the country 22 rock, and so there are chlorite and actinolite 23 rich domains. In some cases, also biotite, which 24 would truly give it the black color. But they 25 would be very dark rocks in comparison to the talc</p>
<p style="text-align: right;">Page 167</p> <p>1 quite the way I should have. 2 But, again, those descriptions are on a 3 regional level, right? They're not specific to 4 any particular mine or samples from that mine, 5 correct? 6 MR. FROST: Objection to form. 7 THE WITNESS: They're specific to the 8 local geology around those mines. 9 BY MR. BURNS: 10 Q Is the local geology similar to the 11 geology found here in Vermont? 12 A I mean, it's a -- it's a different -- 13 it's a different continent. It's got a different 14 history. In this case you have dolomitic marbles 15 that were juxtaposed next to mafic igneous rocks 16 that underwent a tectonic episode 400-something 17 million years ago, where there was ductile 18 deformation associated with the faults that are 19 shown on -- on the map. And you had silica rich 20 fluids present during metamorphism. And so, 21 again, it's a case of metasomatism, a case of 22 chemical exchange. 23 So some elements of the process are the 24 same or similar, but the -- the details of the 25 geology and the rock types are -- are quite</p>	<p style="text-align: right;">Page 169</p> <p>1 rich rocks that they're juxtaposed with. 2 Q I'll hand you what we'll mark as 3 Exhibit 11. 4 MR. BURNS: I think we got these from 5 your materials. Is that where they came from? 6 MR. FROST: Yeah. 7 MS. O'DELL: Yeah. 8 MR. FROST: Yep, that's fine. I know 9 what this is. 10 MR. BURNS: Okay. 11 (Webb Exhibit No. 11 was marked 12 for identification.) 13 BY MR. BURNS: 14 Q Is that the document, Exhibit 14, that 15 you relied on for your opinions with respect to 16 China? 17 A It's one of the documents. 18 Q Okay. Now, that is in Chinese. Do you 19 read Chinese? 20 A I know a few characters. 21 Q Okay. Is there an English translation 22 that you relied on or -- 23 A I asked counsel if -- if that service 24 would be available for this document, and it was 25 provided.</p>

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<p style="text-align: right;">Page 170</p> <p>1 However, even prior to that, though, I</p> <p>2 was able to correlate the -- the map unit names</p> <p>3 that are not in -- in Chinese, and so able to</p> <p>4 deduce -- I don't have it. I'd have to refer to</p> <p>5 the series of documents to point out, but, you</p> <p>6 know, the geologic layer in the map that was</p> <p>7 associated with the -- the talc formation.</p> <p>8 And there are also some chemical</p> <p>9 reactions that are written in English characters,</p> <p>10 and so I can read -- read those. But -- but, yes,</p> <p>11 the details of -- that are hidden in the Chinese</p> <p>12 characters, I relied on the translation for that.</p> <p>13 MR. BURNS: And, Mr. Frost, can you</p> <p>14 provide that?</p> <p>15 MR. FROST: I'm sure I can find it. It</p> <p>16 might even be in the box.</p> <p>17 MS. O'DELL: Do you know how we would</p> <p>18 identify it? Is it --</p> <p>19 MR. FROST: It would say "Lee." I mean,</p> <p>20 I think I could find it in electronic form, and</p> <p>21 I'll e-mail it to you.</p> <p>22 MS. O'DELL: Okay.</p> <p>23 MR. BURNS: Thank you.</p> <p>24 MR. FROST: That might be the easiest</p> <p>25 way to dig it out.</p>	<p style="text-align: right;">Page 172</p> <p>1 these deposits directly. There the talc formed</p> <p>2 early in the history of -- of the rocks. Because,</p> <p>3 again, I mean, the -- this -- this region has,</p> <p>4 again, a very complicated history represented by</p> <p>5 hundreds of millions of years, and, you know,</p> <p>6 they're in the Alps today, but that is a Cenozoic</p> <p>7 collision orogenic event that built up those</p> <p>8 mountains.</p> <p>9 But the -- the people, again, who</p> <p>10 studied the minerals present, their textural</p> <p>11 relationships relative to one another, the</p> <p>12 different structural elements and their relative</p> <p>13 age relationships, all demonstrate -- I mean, it's</p> <p>14 pretty much a consensus out there that the talc</p> <p>15 formed in this pre-carboniferous basement. So,</p> <p>16 you know, the constraint in the literature is</p> <p>17 around 355 million years or -- or prior.</p> <p>18 And the mineral assemblages, again, not</p> <p>19 the talc specifically but in the rocks, the system</p> <p>20 of rocks in which the talc is embedded record</p> <p>21 evidence for metamorphism at up to like 575</p> <p>22 degrees C or so, 600 degrees C, during an older</p> <p>23 orogenic event. And then talc being very stable,</p> <p>24 unless you achieve temperatures much higher</p> <p>25 than -- I mean, close to 700 degrees or higher,</p>
<p style="text-align: right;">Page 171</p> <p>1 MS. O'DELL: Eric, can you do the</p> <p>2 translation?</p> <p>3 MR. FROST: He might be able to. Alex.</p> <p>4 MS. O'DELL: Alex.</p> <p>5 BY MR. BURNS:</p> <p>6 Q You said that was one of the documents.</p> <p>7 What was the -- what were the others?</p> <p>8 A Yao, et al. Zhao, et al. Yao, et al.,</p> <p>9 2016. Zhao, et al., 2018.</p> <p>10 MS. O'DELL: Do you mind spelling those,</p> <p>11 please?</p> <p>12 THE WITNESS: Yao, Y-A-O, et al. And</p> <p>13 Zhao, Z-H-A-O.</p> <p>14 MS. O'DELL: Thank you.</p> <p>15 BY MR. BURNS:</p> <p>16 Q What about the peer-reviewed literature</p> <p>17 allowed you to reach the same conclusions with</p> <p>18 respect to Italy?</p> <p>19 A Well, so in Italy, there's actually more</p> <p>20 direct description of the, I'm going to say,</p> <p>21 Fontane, and it's probably pronounced differently</p> <p>22 in Italy. I'm better with the Chinese</p> <p>23 pronunciations than the Italian.</p> <p>24 So there are a number of publications,</p> <p>25 albeit it a small number, but that do describe</p>	<p style="text-align: right;">Page 173</p> <p>1 that talc basically went for a ride down a</p> <p>2 subduction zone and came back up.</p> <p>3 So that's why I'm familiar with the area</p> <p>4 generally, because it's another case of one of</p> <p>5 these ultra high pressure terrains like I studied</p> <p>6 for my Ph.D.</p> <p>7 But, again, it's a mesomat- -- well,</p> <p>8 there's kind of two theories out there in terms of</p> <p>9 either the talc formed from a sepiolite horizon,</p> <p>10 which has a chemical formula very similar to talc.</p> <p>11 So that transformation would be just a function of</p> <p>12 sepiolite having gotten hot enough to react to</p> <p>13 form talc.</p> <p>14 But the relationship between -- of the</p> <p>15 talc bodies basically being at this interface of,</p> <p>16 again, carbonate rocks and mafic gneisses suggest</p> <p>17 to me, rather, that it was again a case of</p> <p>18 metasomatism, a chemical exchange across rock</p> <p>19 boundaries during high temperature metamorphism</p> <p>20 that allowed the transformation of volumes of rock</p> <p>21 to basically move towards that talc composition.</p> <p>22 So, again, it's the integration of what</p> <p>23 people have seen in terms of mineral assemblages,</p> <p>24 textural relationships, relative age</p> <p>25 relationships, et cetera, that led me to my</p>

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<p style="text-align: right;">Page 174</p> <p>1 opinion.</p> <p>2 Q And what are your principal sources for</p> <p>3 your Italian theories -- or, sorry, opinions?</p> <p>4 MR. FROST: Objection to form.</p> <p>5 THE WITNESS: So could -- those papers</p> <p>6 that I cite here, Cadoppi, et al., 2016; Sandrone,</p> <p>7 et al., 1990; Sandrone and Zucchetti, 1988.</p> <p>8 There's Del Greco and Pelizza, 1984.</p> <p>9 BY MR. BURNS:</p> <p>10 Q Are there any that are not cited in your</p> <p>11 report?</p> <p>12 A I don't believe so. I mean, if they</p> <p>13 are, they would be in the reliance, but I think</p> <p>14 this is the key body of the papers.</p> <p>15 Q Oh, Exhibit 14, that Chinese document,</p> <p>16 how were you able to locate it or find it?</p> <p>17 A I don't remember whether it was with</p> <p>18 GeoRef or using Google Scholar, but I -- you know,</p> <p>19 searching again the scientific literature, and --</p> <p>20 specifically for -- so this is why I asked for</p> <p>21 the -- the Imerys China mine documents was -- I</p> <p>22 used those to get the formation names at the mines</p> <p>23 of interest, and then I searched the literature</p> <p>24 for those formation names.</p> <p>25 The -- the Imerys documents also had</p>	<p style="text-align: right;">Page 176</p> <p>1 You know, part of, I guess, what I'm</p> <p>2 responded to are summary papers like Van Gosen,</p> <p>3 et al., 2004, that at kind of a surficial level,</p> <p>4 if you read that paper, you would come away with</p> <p>5 the impression that it was highly probable.</p> <p>6 But, again, when you dive into the</p> <p>7 details of the geology and you really start to</p> <p>8 understand how these very unique bodies formed,</p> <p>9 there's just -- there's just nothing that would</p> <p>10 lead you to that association.</p> <p>11 Q What about Doll? Anything in Doll that</p> <p>12 you consider not scientifically sound or --</p> <p>13 A The Doll, 1961?</p> <p>14 Q I think that's the right year.</p> <p>15 MR. BURNS: Do you have that handy?</p> <p>16 MS. O'DELL: It may be '65.</p> <p>17 THE WITNESS: I'm not sure I cited that</p> <p>18 or --</p> <p>19 BY MR. BURNS:</p> <p>20 Q It's in your materials. Let's take a</p> <p>21 look. '61.</p> <p>22 MS. O'DELL: '61.</p> <p>23 MR. BURNS: '61.</p> <p>24 THE WITNESS: I mean -- sorry.</p> <p>25 BY MR. BURNS:</p>
<p style="text-align: right;">Page 175</p> <p>1 coordinates of the mines in some cases, and so I</p> <p>2 used those geographic coordinates to, for example,</p> <p>3 determine that I was looking at the same geology</p> <p>4 that's shown in this map figure.</p> <p>5 Q Okay.</p> <p>6 A Or, rather, that the geology shown in</p> <p>7 that map figure described in those articles was</p> <p>8 relevant to the mines.</p> <p>9 Q So turning to subparagraph C on the</p> <p>10 first page of your report, you say: "There is no</p> <p>11 well-founded, scientifically sound evidence in the</p> <p>12 peer-reviewed scientific literature for an</p> <p>13 association of amphibole asbestos with the talc</p> <p>14 deposits of concern."</p> <p>15 So I think we've run through the</p> <p>16 literature you consider well-founded.</p> <p>17 Is there literature out there in the</p> <p>18 peer-reviewed scientific literature that you don't</p> <p>19 consider well-founded or scientifically sound that</p> <p>20 supports the association of amphibole asbestos</p> <p>21 with the talc deposits of concern?</p> <p>22 A I've never seen anything in the</p> <p>23 published peer-reviewed literature that implies</p> <p>24 specifically that there is asbestos in these --</p> <p>25 these talc mines.</p>	<p style="text-align: right;">Page 177</p> <p>1 Q Go ahead.</p> <p>2 A Is that the -- so is that the question,</p> <p>3 Doll 1961?</p> <p>4 Q Yeah, that's the question. I think it's</p> <p>5 '61. Mm-hmm.</p> <p>6 A Doll 1961 is a published bedrock map of</p> <p>7 Vermont.</p> <p>8 Q Mm-hmm.</p> <p>9 A So it is the version that existed prior</p> <p>10 to the update, which is Ratcliffe, et al., 9 -- or</p> <p>11 2011.</p> <p>12 So, yeah, some things have changed.</p> <p>13 There's been some new -- new mapping, some new age</p> <p>14 data that's come out, so, you know, things have</p> <p>15 shifted, but that was the state of knowledge at</p> <p>16 that time.</p> <p>17 Q Mm-hmm.</p> <p>18 MR. BURNS: What's that?</p> <p>19 Leigh, I think you said it was 20.</p> <p>20 MS. O'DELL: 20.</p> <p>21 MR. BURNS: Yeah.</p> <p>22 (Counsel conferring.)</p> <p>23 BY MR. BURNS:</p> <p>24 Q Oh, I see. I thought it was the</p> <p>25 statement of the geologist at the time.</p>

45 (Pages 174 to 177)

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<p style="text-align: right;">Page 178</p> <p>1 We're referring to bedrock geology of</p> <p>2 the Woodstock quadrangle in Vermont by Chang, Ern</p> <p>3 and Thompson. Are you familiar with that?</p> <p>4 A Was that 1965 or thereabouts? I know I</p> <p>5 made reference to one Chang article.</p> <p>6 Q Judging by the font, 1965, you're right.</p> <p>7 A Sorry. I'd just like to find that in my</p> <p>8 report.</p> <p>9 Q Sure.</p> <p>10 MR. FROST: Did you say it was Chang,</p> <p>11 C-H-A-N-G?</p> <p>12 MR. BURNS: Yeah.</p> <p>13 THE WITNESS: Right, I think this -- my</p> <p>14 citation to it relates to the Five Corners mine.</p> <p>15 BY MR. BURNS:</p> <p>16 Q Okay.</p> <p>17 A On page 21.</p> <p>18 Q More broadly, is this an article that</p> <p>19 you considered to be well-founded? Sound --</p> <p>20 scientifically sound?</p> <p>21 A Well, it's -- I wouldn't say I would</p> <p>22 venture an opinion on the entire body of that</p> <p>23 document. I -- again, I looked at that</p> <p>24 specifically with respect to Van Gosen's 2006</p> <p>25 citation. Or maybe he -- no, I forget. Did he</p>	<p style="text-align: right;">Page 180</p> <p>1 if there were enough iron for actinolite to form.</p> <p>2 I also, you know, basically then took a</p> <p>3 subset of that figure to -- for just a smaller</p> <p>4 demonstrative and a smaller version of the</p> <p>5 chemographic diagram in the upper left.</p> <p>6 Q Mm-hmm. Okay.</p> <p>7 A But, otherwise, it's -- it's pretty --</p> <p>8 pretty similar.</p> <p>9 Q Is this diagram -- and forgive me for</p> <p>10 being confused on it -- but would this diagram be</p> <p>11 accurate for the J&J mines in Vermont?</p> <p>12 A Actually, it would, because those</p> <p>13 ultramafic bodies are extremely magnesium rich.</p> <p>14 And so -- yeah, I mean, that ultramafic bulk</p> <p>15 composition, based on the data that have been</p> <p>16 published for a larger and more unaltered body in</p> <p>17 Ludlow and Dover, would -- would plot where</p> <p>18 that -- that purple triangle is.</p> <p>19 THE REPORTER: That what? I'm sorry.</p> <p>20 THE WITNESS: Sorry. Where the purple</p> <p>21 triangle is in the diagram.</p> <p>22 BY MR. BURNS:</p> <p>23 Q Did you plot this for Italy or China?</p> <p>24 A I did not.</p> <p>25 Q Would it differ?</p>
<p style="text-align: right;">Page 179</p> <p>1 actually even cite that and I came across it</p> <p>2 myself?</p> <p>3 Okay. So I found a reference to</p> <p>4 chrysotile in the Five Corners mine in that --</p> <p>5 that document. But Van Gosen actually did not</p> <p>6 include that one.</p> <p>7 I mean, I don't -- I don't take issue,</p> <p>8 you know, with --</p> <p>9 Q Okay.</p> <p>10 A -- chrysotile at the Five Corners mine.</p> <p>11 Q Any other criticisms of that article you</p> <p>12 recall?</p> <p>13 A Not that I think are -- no.</p> <p>14 Q Let's turn to page 13.</p> <p>15 And I'm looking at Figure 7. I believe</p> <p>16 this is chemographic diagrams for the -- oh,</p> <p>17 geez -- calcium oxide, silicon oxide, magnesium</p> <p>18 oxide -- chemical system for calcareous and</p> <p>19 ultramafic rocks modified from Winter, 2001.</p> <p>20 Is that correct?</p> <p>21 A Yes.</p> <p>22 Q Okay. How was it modified?</p> <p>23 A Well -- I think I added color. I also I</p> <p>24 think added the position of actinolite, which</p> <p>25 would plot similarly to tremolite in this system,</p>	<p style="text-align: right;">Page 181</p> <p>1 A Yeah, I mean, those again would be a</p> <p>2 little bit more -- the general principle I'm</p> <p>3 trying to -- to show here holds in the sense that</p> <p>4 in order to make a talc ore, you have to have sort</p> <p>5 of extreme metasomatic events to change the bulk</p> <p>6 composition of the rock to something that is very</p> <p>7 close to -- to talc.</p> <p>8 So in principle, it fits, but in terms</p> <p>9 of that, of that system, because it's limestones</p> <p>10 and marbles juxtaposed next to schist, and then</p> <p>11 mafic, but not ultramafic, the -- the chemical</p> <p>12 components you would need to consider would be</p> <p>13 slightly different.</p> <p>14 Q How would it change the plotting? What</p> <p>15 would be the effect?</p> <p>16 MR. FROST: Objection to form.</p> <p>17 THE WITNESS: Yeah, well, you would</p> <p>18 probably need to combine some chemical components.</p> <p>19 Again, this is -- this is assuming that, you know,</p> <p>20 you've got these three components that are shown</p> <p>21 at the apices of the triangle are dominating the</p> <p>22 system.</p> <p>23 So, depending on what those chemical</p> <p>24 components would be, you would have different</p> <p>25 minerals and minerals plotting in different</p>

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<p style="text-align: right;">Page 182</p> <p>1 positions in that diagram compared to what they 2 are here. 3 BY MR. BURNS: 4 Q And do you have sufficient data for 5 Italy or China to plot something similar? 6 A No. And -- I mean, I could find that, 7 but again this -- the purpose of this was really 8 to try and illustrate the point that while you can 9 have talc in carbonate or ultramafic rocks, with a 10 variety of minerals in your sort of general 11 metamorphic rocks, it takes a special process to 12 make a talc ore. 13 So, you know, I didn't engage in an 14 analysis with this beyond that. It was meant more 15 to -- to try and illustrate a key concept. 16 Q Let's go back -- 17 MS. O'DELL: Jack, would you please 18 provide White, 2001. 19 MR. FROST: If I have it. 20 MS. O'DELL: It's not -- 21 THE WITNESS: It's a textbook. 22 MR. FROST: Oh, is that what it is? 23 THE WITNESS: It's a geology textbook. 24 MR. FROST: Yes. I don't have it, but 25 I'll see if we can do anything during a break.</p>	<p style="text-align: right;">Page 184</p> <p>1 MR. FROST: I'm done with winter. 2 MR. BURNS: That was for the "Game of 3 Thrones" fans in the audience. 4 BY MR. BURNS: 5 Q Going back to page 1 of your report. 6 In that subparagraph C, you say based on 7 your "reviews of the geology associated with the 8 applicable mines, and the pressure and temperature 9 histories recorded by the rocks, any amphibole 10 found in Johnson's Baby Powder and Shower to 11 Shower derived from the Fontane, southern Vermont, 12 and Guangxi talc mines would likely be incidental 13 actinolite or tremolite cleavage fragments from 14 non-asbestiform amphiboles, most likely derived 15 from the margins (blackwall zones) of the talc 16 deposits." 17 Is that correct? 18 A Yes. 19 Q Okay. What do you mean by "incidental 20 actinolite"? 21 A Well, that principally, except right 22 along the -- the margins of the blackwall, you 23 wouldn't expect actinolite to be present in the 24 main body of talc ore, because the bulk 25 composition isn't really appropriate for that.</p>
<p style="text-align: right;">Page 183</p> <p>1 MS. O'DELL: That would be -- that would 2 be good. 3 MR. FROST: Yeah, no promises, though. 4 I can't guarantee I can get it. 5 MS. O'DELL: Well, I mean if she is 6 relying on it, and it's something she has based a 7 figure in her report, then we requested those 8 materials. So I understand the issue, but if you 9 could work on it. 10 MR. FROST: As I said, I'll see -- I'll 11 see if we can -- 12 MR. BURNS: And I think you're referring 13 to Winter, right? 14 THE WITNESS: Yes, Winter. 15 MR. FROST: I was going to say -- 16 MS. O'DELL: Excuse me. Excuse me. 17 Winter. 18 MR. FROST: Winter, I've got a better 19 shot of finding, so at least I know what that is. 20 But I don't know if I can get it, but I'll see 21 what we can do during a break. 22 MR. BURNS: Winter is coming. 23 MR. FROST: That's right. Hopefully 24 not. Spring and summer are coming. 25 MR. BURNS: Thought I'd throw it out.</p>	<p style="text-align: right;">Page 185</p> <p>1 And tremolite, also you wouldn't expect 2 in great volumes in the talc itself, and that's 3 because calcium is an essential element in these 4 minerals. 5 And again, the chemistry that's reported 6 for the -- the Ludlow and Dover bodies, which are 7 our best proxy for the ultramafic protoliths, the 8 mantle rocks that we started with, really low 9 calcium levels, so -- whereas the metasedimentary 10 and metavolcanic wall rocks are -- are more 11 calcium rich, more iron rich. And so, you know, 12 that's where the blackwall -- the actinolite in 13 part -- by definition is part of the blackwall, 14 these actinolite zones. 15 So, I guess "incidental" would mean that 16 some accidental incorporation of -- of the 17 blackwall. 18 Q Meaning that the mining encompassed part 19 or all of that -- of one piece of the blackwall. 20 A Yeah. I mean, I don't -- again, I don't 21 know. Basically, it's like I can't come up with a 22 petrologic argument to say those should be present 23 in any abundance in the -- the talc that was the 24 desired mining product. So it's most likely 25 coming from the margins. But...</p>

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<p style="text-align: right;">Page 186</p> <p>1 Q Okay. Is actinolite a regulated form of 2 asbestos? 3 MR. FROST: Objection to form. 4 THE WITNESS: Asbestiform actinolite is 5 one of the regulated minerals, yes. 6 BY MR. BURNS: 7 Q And you mentioned specifically tremolite 8 cleavage fragments; is that correct? 9 A Well, actinolite or tremolite cleavage 10 fragments. 11 Q Okay. So both -- both modified -- 12 A Yeah, meaning that this actinolite, the 13 tremolite is not -- asbestiform did not grow in 14 that primary growth habit, and rather, could be 15 ablated or acicular or prismatic tremolite that -- 16 I guess then if it's -- somehow in the talc 17 undergoes, you know, the beneficiation process, 18 so crushing and grinding and breakdown into 19 cleavage fragments. 20 Q So is it your testimony then that there 21 would be no asbestiform actinolite or tremolite in 22 the talc? 23 A That's -- yes, that's my testimony. 24 Q Okay. Let's turn to page 11. And to 25 Figure 6.</p>	<p style="text-align: right;">Page 188</p> <p>1 temperature conditions under which the talc ores 2 formed. 3 Q In all of the Fontane, southern Vermont 4 and Guangxi talc ores; is that right? 5 A Yeah. In general, there's some overlap 6 there. Guangxi would be more firmly in the 7 greenschist boundary; Vermont would be more in the 8 epidote-amphibolite facies, with the Fontane as 9 well. 10 Q Okay. So there's a note in your 11 description of Figure 6 that: "Conditions 12 favoring asbestos formation are generally 13 associated with low-temperature and/or 14 low-pressure conditions," and then you describe 15 the zeolite, prehnite, prehnite-pumpellyite -- 16 A Yeah, prehnite-pumpellyite. 17 Q Pumpellyite. Thank you. 18 -- and hornfels facies, right? 19 A Yes. 20 Q Okay. And just so we are all on the 21 same page and we can look at the same thing for a 22 second, I'm going to circle each of those areas. 23 See if I get them all correctly. I've 24 tried to circle here the areas where conditions 25 favor asbestos formation. Did I capture them all?</p>
<p style="text-align: right;">Page 187</p> <p>1 So Figure 6 is a "Pressure-temperature 2 diagram modified from Winter (2001), showing in 3 gray the general boundaries of the different 4 metamorphic facies (for example, greenschist 5 facies) that represent conditions under which 6 certain combinations of minerals (i.e., 7 equilibrium assemblages) are stable as a function 8 of a rock's bulk composition." 9 Is that right? 10 A Yes. 11 Q How was this modified from Winter? 12 A I added in -- I believe the reaction 13 curve for chrysotile and lizardite maximum 14 stability, and that was taken from Evans, 2004. 15 Q And that was the tremolite? 16 A That was the chrysotile -- 17 Q Chrysotile. Sorry. 18 A -- and lizardite maximum stability, the 19 brown dashed curve at around 300 degrees C. 20 Q So Evans, 2004? 21 A Yes. 22 Q Okay. 23 A And then I also added the -- the green 24 roughly oval-shaped region that was meant to 25 encompass the -- the general range of pressure and</p>	<p style="text-align: right;">Page 189</p> <p>1 A Yeah. I mean, in terms of low 2 temperature, that could extend up to the -- the 3 blueschist facies. 4 Q Mm-hmm. 5 A I mean, the key thing is there, again, 6 low-temperature deformation tends to be more 7 brittle and -- and allow the -- the ability for 8 fractures to open, which is one of the -- the most 9 common site for asbestos to -- to form. 10 Q Okay. Now, is it -- 11 MR. FROST: Just a -- I'm just going to 12 object to some of the circles. It seems different 13 than what's listed at the bottom of Figure 6. 14 MR. BURNS: And if it is, let me know. 15 THE WITNESS: The hornfels, I was just 16 speaking generally to the -- the high temperature, 17 low -- low pressure. So... 18 BY MR. BURNS: 19 Q So would it include the albite-epidote- 20 hornfels, which looks to be low pressure, 21 relatively low temperature or -- 22 A Yeah. I don't have an issue with what 23 you circled. I mean -- 24 MR. FROST: I just wanted the record to 25 be clear.</p>

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<p style="text-align: right;">Page 190</p> <p>1 MR. BURNS: Mr. Frost -- Mr. Frost does, 2 but -- 3 MR. FROST: But I just wanted to make 4 sure the record was clear. 5 MR. BURNS: All right. Fair enough. 6 BY MR. BURNS: 7 Q So you mention -- mentioned fractures. 8 And I believe you said that fractures are one of 9 the conditions where asbestos can form. Is that 10 correct, or something along those lines? 11 A Yes, most -- most commonly as those 12 cross fibers or slip fibers. 13 Q Mm-hmm. So, speaking generally and 14 recognizing -- well, strike that. 15 Not having your background and 16 expertise, I have some general questions about 17 this. 18 So it appears from this figure that the 19 talc in the Fontane and Vermont and Guangxi ores, 20 in your view, based on its -- based on I guess 21 that regional petrology and circumstances there, 22 would have formed at about, what, 500 degrees 23 Celsius and 0.6 GPA pressure; is that right? 24 A That's a good ballpark. 25 Q Okay. And the conditions for the</p>	<p style="text-align: right;">Page 192</p> <p>1 with depth because of the weight of the overlying 2 column of rocks, and so if you're at low 3 pressures, the rocks are a bit -- a bit weaker, 4 but you don't have that pressure that basically 5 fights against voids opening. 6 So the rocks either have to be low 7 temperature and brittle because of that or shallow 8 in the earth's crust to basically not have enough 9 weight down on you to -- to keep voids from 10 opening. 11 You know, whereas the -- the conditions 12 of metamorphism for the formation of talc, much 13 higher temperatures and, you know, 20 kilometers 14 deep. That's pretty deep in the continental 15 crust. And we know from people who have studied 16 the -- again, the structures that these were 17 undergoing ductile deformation at the time. 18 So it's just those geologic conditions 19 aren't -- that's why I say they aren't favorable, 20 aren't -- aren't amenable. 21 Q At the same time, right? Is that the 22 issue? 23 MR. FROST: Objection. 24 BY MR. BURNS: 25 Q It would be difficult to have the same</p>
<p style="text-align: right;">Page 191</p> <p>1 creation of asbestos sort of surround that area, 2 but obviously at different pressures and different 3 temperatures. 4 Would minor variations in temperature or 5 in pressure, had they occurred, could those have 6 resulted in asbestos materials coming into the 7 same ores? 8 A I don't -- 9 MR. FROST: Object to form. 10 THE WITNESS: I don't believe so. 11 BY MR. BURNS: 12 Q And why? 13 A Well, again, when you're at the low 14 temperature end and rocks are -- would deform 15 brittly, again that's generally when fractures 16 could open. And because of the primary growth 17 habit of asbestiform fibers, they're basically 18 growing into -- into void spaces. So that's a 19 precondition, coupled with fluids that are 20 saturated and the chemical components from which 21 the asbestiform minerals would grow. 22 When you look at the -- when I say -- or 23 generally the hornfels conditions here, yeah, you 24 have higher temperatures, but you also have very 25 low pressures. And so rock strength increases</p>	<p style="text-align: right;">Page 193</p> <p>1 conditions exist at the same time for the creation 2 of both the asbestos materials and the talc ores. 3 Is that right? 4 MR. FROST: Object to the form. 5 THE WITNESS: Yeah, I mean, I would say 6 that, yes, at the time the talc was forming, the 7 conditions were not appropriate. 8 BY MR. BURNS: 9 Q Okay. Now -- but I believe we've 10 described circumstances where -- I'm thinking of 11 Italy where you said the talc may have formed 12 earlier in the continent's subduction zone, but 13 have survived the subduction. 14 Is it possible that -- are there 15 circumstances where asbestos could form at a later 16 time and under favorable circumstances where the 17 talc would remain solid, because it's a stable 18 mineral, but a fracture, for example, could lead 19 to the incorporation of asbestiform materials? 20 MR. FROST: Objection to form. 21 THE WITNESS: Well, I mean, I suppose we 22 could devise a hypothetical situation where the 23 conditions were all ripe for this to happen, but 24 there's no evidence that that's the case. 25 As I said, all asbestos in Vermont,</p>

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<p style="text-align: right;">Page 194</p> <p>1 everybody has written about it, there's no 2 disagreement that that occurred, you know, 80 3 million years prior to the formation of the talc, 4 give or take a few million years. 5 And the conditions that postdated the 6 formation of the Italian talc in the Fontane mine 7 were way up here (indicating). So, I mean, maybe 8 similar in temperature, but much, much higher -- 9 higher pressures. Yeah, they're back at the -- 10 the surface today, but, you know, I think -- 11 again, when asbestos forms, it's -- it's regional 12 conditions that allow that to occur, and so we'd 13 have other -- I would expect to see that 14 documented throughout the -- the geology. And I 15 just -- you know, I don't see any evidence for it. 16 BY MR. BURNS: 17 Q Turning to the Vermont example where the 18 asbestos formed before the talc, are fractures 19 again a potential explanation for migration of the 20 asbestos -- 21 MR. FROST: Objection to form. 22 BY MR. BURNS: 23 Q -- subsequently? 24 A I've never heard of migration of 25 asbestos, so I don't know --</p>	<p style="text-align: right;">Page 196</p> <p>1 along that, and that's when you would get the 2 fibrils basically at an angle to the -- to the 3 fracture walls connecting on either side. 4 Q Okay. And you say that is the most 5 common means by which the asbestos occurs in 6 Vermont? 7 A (The witness nods.) 8 Q But not with respect to the J&J mines. 9 MR. FROST: Objection to form. 10 THE WITNESS: I'm -- I don't know what 11 you mean by that. Sorry. 12 BY MR. BURNS: 13 Q Well, meaning because you haven't seen 14 any evidence of asbestos in the J&J mines, what 15 you're describing there would not be true of those 16 mines? 17 A Yeah. 18 MR. FROST: Objection to form again. 19 BY MR. BURNS: 20 Q Given the geologic -- given the 21 geology -- the local geology of the J&J mines, 22 would that process have been possible? 23 A I mean, again, we could devise a 24 hypothetical situation that might satisfy those 25 conditions, but I --</p>
<p style="text-align: right;">Page 195</p> <p>1 Q Well, I didn't really mean migration. I 2 mean the filling in of those -- those fractures 3 with the asbestiform materials. 4 A I mean, dominantly in Vermont where 5 asbestos is documented, it's says cross and slip 6 fibers. 7 Q And what do you mean by that? 8 A That basically as these fractures were 9 opening, they're apparently, you know, filled with 10 fluid at the same time that became saturated in 11 the chemical component, so the chrysotile chemical 12 formula basically, that those minerals or, you 13 know, fibrils nucleated on walls of -- of the 14 fractures, and depending on whether they opened 15 like that or like that (demonstrating), in this 16 case they appear to continue to grow as the 17 fracture continues to open. So it's -- the 18 nucleate on either side and -- or there are some 19 veins where things nucleate in the middle 20 initially, and then grow outward as well. 21 But in any case, the fibrils would be 22 growing as the fracture is opening. So cross 23 fibers would be perpendicular to the fracture 24 walls. Slip fibers would be one of those 25 fractures where there's, you know, some offset</p>	<p style="text-align: right;">Page 197</p> <p>1 Q I realize you haven't seen it, but 2 would -- would it be possible? 3 MR. FROST: Objection to form. 4 Inappropriate hypothetical. 5 THE WITNESS: Yeah, I'm sorry, I don't 6 know how to -- you know, lots of things are 7 possible, but many things don't happen. So I 8 can't -- I don't -- I can't comfortably answer 9 that without having all of the variables sort of 10 outlined for me and -- 11 BY MR. BURNS: 12 Q Well, I certainly understand that, but 13 really I -- we're talking about a pretty small set 14 of variables, the ones you described as relatively 15 common in Vermont in terms of the formation of 16 asbestos materials. 17 And what I'm saying is, given the 18 regional geology that's present in the J&J mines, 19 is it possible -- not probable, not, you know, 20 highly possible -- but is it possible that that 21 process of the creation of asbestos may -- may 22 have occurred in a similar fashion in those J&J 23 mines? 24 MR. FROST: Same objection to form and 25 inappropriate hypothetical.</p>

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<p style="text-align: right;">Page 198</p> <p>1 THE WITNESS: Yeah, like I said, we 2 could devise a -- a scheme presumably in which 3 that could occur, but it's -- while it might be 4 possible in some parallel universe, I -- I just -- 5 it's not probable, and I just don't see any 6 evidence for it having occurred here. 7 BY MR. BURNS: 8 Q Well, what would constitute evidence for 9 you in that context? 10 MR. FROST: Objection to form. 11 THE WITNESS: Well, I would imagine that 12 in that belt of rocks, people would record 13 fractures filling with asbestos, more generally, 14 in the literature. Because, again, people have 15 been looking at these rocks for over a hundred 16 years. People are certainly interested and 17 concerned about asbestos. 18 So, had -- you know, it would be 19 documented in some of these, you know, Vermont 20 state reports, the USGS reports in the 21 peer-reviewed literature around the Chester dome, 22 and it's just -- it's not in anybody's data and 23 observations in the -- in the field. 24 BY MR. BURNS: 25 Q Well, what if it -- and this -- just</p>	<p style="text-align: right;">Page 200</p> <p>1 THE WITNESS: Yeah, and I did not find 2 any, because, again, the vast majority of what I 3 looked at was my own research. 4 MR. BURNS: Okay. 5 THE WITNESS: Can I take a quick break? 6 MR. BURNS: Oh, of course, sure. 7 THE WITNESS: I've been drinking a lot 8 of water and tea and -- 9 MR. FROST: Yeah, I was going to say, 10 actually, I could use the restroom. 11 THE VIDEOGRAPHER: Going off the record 12 at 4:26. 13 (Recess.) 14 THE VIDEOGRAPHER: We're back on the 15 record at 4:57 p.m. 16 BY MR. BURNS: 17 Q Welcome back, Dr. Webb. 18 So, Dr. Webb, we were talking about when 19 last we left off, evidence -- evidence for 20 asbestos in talc in the J&J mines in Vermont, 21 specifically. 22 MR. BURNS: Let's go ahead and mark 23 this, Amanda. 24 (Webb Exhibit No. 12 was marked 25 for identification.)</p>
<p style="text-align: right;">Page 199</p> <p>1 throwing this out there, what if -- what if it was 2 documented in a core log or observations by the 3 mining company at, say, the Argonaut mine, would 4 you consider that evidence? 5 MR. FROST: Objection. 6 BY MR. BURNS: 7 Q That would at least merit additional 8 testing? 9 MR. FROST: Objection to form. 10 THE WITNESS: Well, I mean, you know, if 11 you've got evidence where people have -- I mean, 12 where I can understand the methodology that was 13 used and see the data and observations -- I don't 14 want to take some random person who I don't know 15 their qualifications or what they're describing. 16 You know, so I'd be happy to -- if you've got 17 something you want me to look at that -- that 18 presents that, to consider it, sure. 19 BY MR. BURNS: 20 Q Okay. But you weren't presented any 21 such evidence when you were doing your report. 22 MR. FROST: Objection to form. 23 BY MR. BURNS: 24 Q Correct? 25 MR. FROST: Supposes there's evidence.</p>	<p style="text-align: right;">Page 201</p> <p>1 BY MR. BURNS: 2 Q All right. I'm going to hand you what 3 we've marked as Exhibit 12. 4 And just let me know when you are ready, 5 if you want to take a second to look it over. 6 A Okay. (Peruses document.) 7 Okay. 8 Q All right. Dr. Webb, have you seen 9 this -- well, let me start. 10 Exhibit No. 12 is a document bearing the 11 Bates labels IMERYYS 219720-722. It appears to be 12 dated March 25th, 1992. Title appears to be 13 "Cyprus Ore Reserves - Arsenic & Tremolite." 14 Did I pronounce that -- or did I read 15 that correctly? 16 A "Cyprus Ore Reserves - Arsenic & 17 Tremolite," yes. 18 Q Okay. Great. 19 Have you seen this document before? 20 A I have not. 21 Q Okay. This -- and have you had a chance 22 to read it? 23 A I did, yes. 24 Q Okay. And is it fair to say that this 25 document contains some discussion about the</p>

<p style="text-align: right;">Page 202</p> <p>1 presence of asbestos materials in talc deposits in 2 Vermont? 3 A It mentions fibrous amphiboles. 4 Q Including tremolite; is that right? 5 A Yes. 6 Q Okay. Is this the type of evidence that 7 would give you some concern if you had been 8 presented it when conducting your analysis? 9 A Not really, because fibrous is a -- a 10 general term for maybe an elongate or long aspect 11 ratio, but it's imprecise, and so it doesn't 12 necessarily indicate asbestos. 13 Q Fibrous tremolite? 14 A Yes. 15 Q It doesn't indicate asbestos to you? 16 A No. 17 Q Okay. Why is that? 18 A Again, because "fibrous" is used by 19 different people in different ways, and I've seen 20 many instances in the literature where it's used 21 for -- synonymously with like acicular. I mean, 22 I've used the terms "fibrous" in my work when I'm 23 talking about working with fault zones and -- and 24 quartz fibers, for example. But, again, it's 25 because they're crystals with long aspect ratios,</p>	<p style="text-align: right;">Page 204</p> <p>1 THE WITNESS: Well, again, I mean, it's 2 the use of the -- fiber's an imprecise term. I 3 mean, obviously they don't want asbestos in -- in 4 their product, so -- but, again, I don't -- I 5 don't see anything here that -- that indicates 6 this term is -- is really -- equates to 7 asbestiform. So... 8 BY MR. BURNS: 9 Q Well, the next paragraph down says: 10 "Vermont talcs are derived from altered serpentine 11 - a natural host for asbestiform minerals. There 12 is certainly visible tremolite and actinolite in 13 specific zones of the Vermont deposits - fibrous 14 tremolite was identified by the writer in 15 exposures and cores at the East Argonaut and Black 16 Bear mines. Cyprus staff report past tremolite 17 from the Hammondsville and Clifton deposits." 18 Did I read that correctly? 19 A Sorry. Where was -- 20 Q That's the fifth paragraph down, page 2. 21 A Yeah. So, I mean, you know, in general, 22 tremolite, I'm not concerned about that. 23 Tremolite means to me -- again, without -- unless 24 it's really described in detail, that's consistent 25 with the asbestiform habit, which again is a</p>
<p style="text-align: right;">Page 203</p> <p>1 and it's -- it's not synonymous, not -- you can't 2 take this to -- to indicate asbestiform tremolite. 3 Q Have you -- what would you -- what else 4 would you need to take it to mean asbestiform 5 tremolite? 6 A Well, some detailed description about 7 the habit of the minerals that is consistent with 8 the definition of "asbestiform." 9 Q Well, so I'll direct you on page 2 to 10 the fourth paragraph down. 11 It says: "Cyprus claims that there are 12 no fibres in their cosmetic talc products, and 13 they work rigorously to ensure this. However, a 14 recent paper published by Rutgers University 15 worker, Alice Blount, suggests the presence of 16 fibre in several cosmetic talcs, some of which 17 might have been from Cyprus West Windsor material, 18 which is a source of great concern to Cyprus 19 management, and potentially to their principal 20 customer, Johnson & Johnson." 21 Why would Cyprus be concerned about 22 fibrous asbestiform materials, including 23 references to fibrous tremolite, if it were not 24 asbestos? 25 MR. FROST: Objection to form.</p>	<p style="text-align: right;">Page 205</p> <p>1 primary growth habit. 2 You know, I'm not shocked that there's 3 tremolite here. I'm not shocked that there's 4 maybe acicular tremolite or, you know, tremolite 5 that someone might describe, depending on how they 6 used the term "fiber," as -- as fibrous. But I 7 can't -- I can't take anything in here and say, 8 This leads me to believe that there's actually 9 asbestos that's been identified. 10 Q Is asbestiform tremolite a regulated 11 form of asbestos? 12 A Asbestiform tremolite is a regulated 13 form, yes. 14 Q Are you able to discern from the 15 terminology used in this memo -- are you -- strike 16 that. 17 Are you able to exclude the possibility 18 that the tremolite referenced in this memo is 19 indeed asbestiform tremolite? 20 MR. FROST: Objection to form, calls for 21 speculation. 22 THE WITNESS: Well, again, I mean, 23 asbestos is so rare, and, again, takes these 24 special conditions that -- 25 I'm sorry, I lost the -- the question.</p>

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<p>1 BY MR. BURNS:</p> <p>2 Q No problem. I simply asked, can you</p> <p>3 exclude the possibility that this is asbestiform</p> <p>4 tremolite that's referenced in the memo?</p> <p>5 A Based on everything I have learned and</p> <p>6 reviewed and understand, yeah, I -- I just</p> <p>7 can't -- I can't read this and say that this</p> <p>8 convinces me of anything. I'd, again, need to see</p> <p>9 field photographs of what this worker saw or</p> <p>10 photomicrographs, the -- again, a real distinct</p> <p>11 description that is consistent with the</p> <p>12 asbestiform habit. And fibers, fibrous, just --</p> <p>13 it could mean anything. It could mean a number of</p> <p>14 things.</p> <p>15 Q So it's fair to say that reading this,</p> <p>16 you would need to see more?</p> <p>17 A Yes.</p> <p>18 Q Okay. Now, there's a reference in the</p> <p>19 sixth paragraph down. It says: "Tremolite in</p> <p>20 these deposits is encountered in the contact zones</p> <p>21 between the talc and the surrounding schist; in</p> <p>22 'grey talcs' in the vicinity of the contacts; and</p> <p>23 associated with the chlorite/amphibole waste zones</p> <p>24 within the talc ores that are locally termed</p> <p>25 'cinders.'"</p>	<p>1 that. If you've seen, I mean, asbestos in a hand</p> <p>2 sample, which hopefully you've never held in your</p> <p>3 hands, I know, but we've got drawers in the rock</p> <p>4 collection at UVM -- I mean, asbestos is pretty</p> <p>5 apparent when you see it in -- in person at the</p> <p>6 macroscopic scale.</p> <p>7 BY MR. BURNS:</p> <p>8 Q Okay.</p> <p>9 A Yeah.</p> <p>10 Q And in the microscopic scale, what are</p> <p>11 you looking for? Is there a certain aspect ratio</p> <p>12 of the fibers that you're trying to determine?</p> <p>13 MR. FROST: Same objection. Beyond the</p> <p>14 scope of her report and her expertise.</p> <p>15 THE WITNESS: Yeah, I mean, there's no</p> <p>16 one specific aspect ratio. Again, you would -- if</p> <p>17 it were -- if it were broken down and you were</p> <p>18 looking at a loose pile of this -- well, again, in</p> <p>19 bulk, I think it would be clear because you would</p> <p>20 have long fibrils and bundles, and there would</p> <p>21 probably be some that might be curved and they</p> <p>22 might be quite long.</p> <p>23 In -- under the microscope, I mean, you</p> <p>24 would be looking for the same thing, long -- long</p> <p>25 aspect ratios, but, again, nothing specific</p>
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<p>1 Do you see that?</p> <p>2 A Yes.</p> <p>3 Q Are you familiar with the term</p> <p>4 "cinders"?</p> <p>5 A I've heard it. I mean, it's not a term</p> <p>6 that I throw around, but...</p> <p>7 Q What is your understanding of what it</p> <p>8 describes in -- in layman's terms?</p> <p>9 A Like I said, I've heard it, but it's not</p> <p>10 something I use, and so it's not something I feel</p> <p>11 prepared to define for you.</p> <p>12 Q Have you ever investigated cinders in</p> <p>13 your -- in your work?</p> <p>14 A No.</p> <p>15 Q When -- were you to investigate --</p> <p>16 strike that.</p> <p>17 Were you to examine a sample of</p> <p>18 tremolite to determine whether it was asbestiform,</p> <p>19 what would you do?</p> <p>20 MR. FROST: Objection to form. Outside</p> <p>21 of the scope of her expertise.</p> <p>22 THE WITNESS: Well, I mean, I think it</p> <p>23 would start with the recognition of -- of fibrils,</p> <p>24 bundles of fibrils, and, I mean, you could</p> <p>25 recognize that in an outcrop if -- if you saw</p>	<p>1 because it might vary in -- in the population</p> <p>2 you're looking at.</p> <p>3 BY MR. BURNS:</p> <p>4 Q Would a 5-to-1 ratio suffice?</p> <p>5 MR. FROST: Same objection.</p> <p>6 THE WITNESS: No.</p> <p>7 BY MR. BURNS:</p> <p>8 Q No?</p> <p>9 A (Witness shakes head.)</p> <p>10 Q Are you aware that that's the ratio</p> <p>11 specified by the National Institute of</p> <p>12 Occupational Safety and Health?</p> <p>13 MR. FROST: Objection to form.</p> <p>14 Misstates document.</p> <p>15 THE WITNESS: I -- I know that there are</p> <p>16 5-to-1 and 3-to-1, depending on the -- my -- the</p> <p>17 source of the -- the counting criteria, that there</p> <p>18 are small-aspect-ratio cutoffs for like that.</p> <p>19 But, again, you know, that's in cases -- those</p> <p>20 ratios were developed for cases when there's</p> <p>21 abatement of known asbestos at hand.</p> <p>22 So, you know, I would say that I</p> <p>23 regularly run into minerals that would meet that</p> <p>24 criteria, 3-to-1 or 5-to-1, and they're -- you</p> <p>25 know, they can be quite -- well, not that large,</p>

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<p style="text-align: right;">Page 210</p> <p>1 but, you know -- so, again, scale matters as well.</p> <p>2 But, yeah, I don't think that's a -- an</p> <p>3 accurate cutoff or criterion for -- for issues</p> <p>4 outside of abatement.</p> <p>5 MR. BURNS: Let's mark this one, Amanda.</p> <p>6 BY MR. BURNS:</p> <p>7 Q We'll mark this as Exhibit No. 13,</p> <p>8 Dr. Webb.</p> <p>9 (Webb Exhibit No. 13 was marked</p> <p>10 for identification.)</p> <p>11 THE WITNESS: (Peruses document.)</p> <p>12 Okay.</p> <p>13 BY MR. BURNS:</p> <p>14 Q All right, Dr. Webb. Exhibit 13 is a</p> <p>15 document with Bates label IMERYS 28 -- 238270</p> <p>16 through 238277, and it's titled "Interoffice</p> <p>17 Correspondence," "Subject: Hamm Mine Core</p> <p>18 Drilling."</p> <p>19 The second paragraph, Dr. Webb, contains</p> <p>20 the following sentence: "Fibrous amphiboles</p> <p>21 (actinolite) were observed only within chloritized</p> <p>22 mafic dikes, extending, in places, a couple of</p> <p>23 inches into the contacting talc ore."</p> <p>24 Did I read that correctly?</p> <p>25 A Yes.</p>	<p style="text-align: right;">Page 212</p> <p>1 THE WITNESS: No, because, I mean, up</p> <p>2 and down Vermont, near talc, away from talc,</p> <p>3 people describe a lot of fibrous amphiboles, and,</p> <p>4 you know, virtually in all cases they refer to --</p> <p>5 this term is used for an acicular habit that is</p> <p>6 distinctly different from asbestiform.</p> <p>7 So, I mean, nothing I read here is</p> <p>8 surprising to me. It -- it doesn't raise the</p> <p>9 questions that, you know -- again, in the absence</p> <p>10 of detailed descriptions, there's --</p> <p>11 BY MR. BURNS:</p> <p>12 Q And that's even though up and down</p> <p>13 Vermont, the presence of confirmed asbestos has</p> <p>14 occurred?</p> <p>15 MR. FROST: Objection to form.</p> <p>16 THE WITNESS: Virtually all of that is</p> <p>17 chrysotile, and not amphiboles, and, yeah, there's</p> <p>18 a lot of amphibole in -- in the Green Mountains,</p> <p>19 and so -- I mean, long aspect ratio amphiboles</p> <p>20 are -- are garden variety amphiboles in our state.</p> <p>21 MR. BURNS: Let's mark this one -- 14?</p> <p>22 (Webb Exhibit No. 14 was marked</p> <p>23 for identification.)</p> <p>24 THE WITNESS: Does anybody have a</p> <p>25 magnifying glass handy? Shall I do --</p>
<p style="text-align: right;">Page 211</p> <p>1 Q Is this the type of statement that would</p> <p>2 cause you to want to seek more information?</p> <p>3 A Not necessarily, because, again, fibrous</p> <p>4 amphiboles, in general, 99 percent of the time</p> <p>5 will not necessarily refer to asbestiform</p> <p>6 actinolite, and -- I mean, I've seen images where,</p> <p>7 yeah, most of these amphiboles in the region have</p> <p>8 these long aspect ratios, but, again, they do not</p> <p>9 meet the criterion of -- of the asbestiform habit.</p> <p>10 Q And what criterion are you speaking of</p> <p>11 in that context?</p> <p>12 A Again, well, primary growth habit of</p> <p>13 fibrils in -- generally in bundles that have long</p> <p>14 aspect ratios but high flexibility, relatively</p> <p>15 defect-free surfaces which impact or -- are part</p> <p>16 of what leads to their chemical resistance.</p> <p>17 So, again, without photomicrographs or</p> <p>18 photos that really give the details of what is</p> <p>19 meant by fibrous, there's no way to extrapolate</p> <p>20 from this the presence of asbestos.</p> <p>21 Q But given the potential risk and the --</p> <p>22 and the fact that you can't exclude the</p> <p>23 possibility of asbestos, wouldn't you want to seek</p> <p>24 additional information?</p> <p>25 MR. FROST: Objection to form.</p>	<p style="text-align: right;">Page 213</p> <p>1 BY MR. BURNS:</p> <p>2 Q And just to help you out, I'm going to</p> <p>3 point you to -- you're welcome to look at the</p> <p>4 whole thing -- I'm going to focus on the back side</p> <p>5 of page 2.</p> <p>6 A So, yeah, the page where I asked for --</p> <p>7 Q The page where you needed a magnifying</p> <p>8 glass.</p> <p>9 A I do have reading glasses in my --</p> <p>10 Q Well, let's see, do we have a clean copy</p> <p>11 here? I can probably blow it up a little bit</p> <p>12 here.</p> <p>13 MR. FROST: You can take this one. It's</p> <p>14 clean.</p> <p>15 MR. BURNS: All right.</p> <p>16 MR. FROST: Is that -- can you see that</p> <p>17 better, Laura?</p> <p>18 MR. BURNS: Not yet.</p> <p>19 MR. FROST: He's going to try to zoom in</p> <p>20 on it.</p> <p>21 THE WITNESS: I mean, actually, can I</p> <p>22 get my glasses, and --</p> <p>23 MR. BURNS: Sure, absolutely.</p> <p>24 THE VIDEOGRAPHER: Going off the record</p> <p>25 at 5:22 p.m.</p>

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<p style="text-align: right;">Page 214</p> <p>1 (Pause.)</p> <p>2 THE VIDEOGRAPHER: We're back on the</p> <p>3 record at 5:24 p.m.</p> <p>4 BY MR. BURNS:</p> <p>5 Q Okay, Dr. Webb, you have Exhibit 14 in</p> <p>6 your hand, which bears Bates label IMERYYS 436951</p> <p>7 through IMERYYS 436971.</p> <p>8 Just one question about Exhibit 13, the</p> <p>9 preceding exhibit, just a quick question. Had you</p> <p>10 seen that exhibit before?</p> <p>11 A No.</p> <p>12 Q Okay. So same question with respect to</p> <p>13 Exhibit 14 to start, is this a document you've</p> <p>14 seen before?</p> <p>15 A No.</p> <p>16 Q Okay. Let's focus on the fourth page in</p> <p>17 the documents, IMERYYS 436954.</p> <p>18 A Sorry, is the first -- is this page 1?</p> <p>19 Q Yes.</p> <p>20 A Oh, okay. So it's the back of the</p> <p>21 second sheet. Yeah, okay.</p> <p>22 Q That's right.</p> <p>23 A I'm making sure it's what I actually</p> <p>24 looked at.</p> <p>25 Q No problem. And I've put it up on the</p>	<p style="text-align: right;">Page 216</p> <p>1 A Yes.</p> <p>2 Q Would these notations cause you to want</p> <p>3 to inquire more as to the nature of these test</p> <p>4 findings or core samples and the constituency of</p> <p>5 the minerals?</p> <p>6 MR. FROST: Objection to form.</p> <p>7 THE WITNESS: Yeah, I mean, again, the</p> <p>8 presence of actinolite around the ore bodies is,</p> <p>9 you know, not a shocker whatsoever. I mean, so it</p> <p>10 doesn't surprise me.</p> <p>11 You know, in terms of "detrimental</p> <p>12 minerals," I don't know what they mean. Obviously</p> <p>13 these are things that they don't necessarily</p> <p>14 want in the -- I mean, I don't want to rub</p> <p>15 actinolite on my face, asbestiform or</p> <p>16 non-asbestiform, but --</p> <p>17 BY MR. BURNS:</p> <p>18 Q Are those questions you would want to</p> <p>19 ask the author?</p> <p>20 MR. FROST: Objection to form.</p> <p>21 THE WITNESS: No, again, because I</p> <p>22 wouldn't be surprised about the -- the presence of</p> <p>23 actinolite generally that -- you know, I'd see</p> <p>24 this and move on, and again try and find -- well,</p> <p>25 like in the materials that I looked at, some --</p>
<p style="text-align: right;">Page 215</p> <p>1 ELMO, just so we can have a little bit better view</p> <p>2 of it. I don't know if that's better for you</p> <p>3 or --</p> <p>4 A I'll look at where you're pointing at,</p> <p>5 and then I'll confer with this too.</p> <p>6 Q Okay. These appear to be and are titled</p> <p>7 "Ore Characterization Summary Sheets." Do you</p> <p>8 agree with that?</p> <p>9 A What was the first word you said,</p> <p>10 "before"?</p> <p>11 Q "Ore Characterization Summary Sheets."</p> <p>12 A Yes, this says "Ore Characterization</p> <p>13 Summary Sheets," yes.</p> <p>14 Q Okay. And there appear to be two of</p> <p>15 these summary sheets side by side dated September</p> <p>16 '92, specifying ore types and associated</p> <p>17 materials.</p> <p>18 A Yes.</p> <p>19 Q And you see in both the presence of</p> <p>20 actinolite and serpentine is indicated.</p> <p>21 A Yeah.</p> <p>22 Q Okay. And they are also -- the</p> <p>23 actinolite and -- the actinolite is noted as a</p> <p>24 detrimental mineral below each notation; is that</p> <p>25 right?</p>	<p style="text-align: right;">Page 217</p> <p>1 some indication, some description that would</p> <p>2 equate this actinolite to asbestiform actinolite.</p> <p>3 BY MR. BURNS:</p> <p>4 Q Well, if you were blindfolded and the</p> <p>5 person who obtained and tested the sample told you</p> <p>6 that it contained actinolite, would you want to</p> <p>7 rub that on your face?</p> <p>8 MR. FROST: Objection to form.</p> <p>9 THE WITNESS: It would hurt. I mean, it</p> <p>10 would be gritty.</p> <p>11 BY MR. BURNS:</p> <p>12 Q If it was asbestiform, it may be even</p> <p>13 worse.</p> <p>14 MR. FROST: Objection to form.</p> <p>15 THE WITNESS: Well, yeah -- but, yeah, I</p> <p>16 mean, again, you know, actinolite is no surprise.</p> <p>17 I talk about actinolite in my -- in my report. In</p> <p>18 the absence of clearcut asbestiform habit --</p> <p>19 BY MR. BURNS:</p> <p>20 Q You're just not interested in knowing</p> <p>21 more?</p> <p>22 MR. FROST: Objection to form.</p> <p>23 THE WITNESS: I mean, well -- yeah, I</p> <p>24 mean, I -- I feel like I'm not surprised to see</p> <p>25 actinolite show up occasionally in the tests, and</p>

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<p style="text-align: right;">Page 218</p> <p>1 that is not a surprise. It's known. I don't know 2 what else to say. It's -- 3 BY MR. BURNS: 4 Q Have you drawn any -- are you prepared 5 to offer any opinions with respect to the presence 6 or absence of arsenic in the talc in the J&J 7 mines? 8 A I mean, I -- I'm familiar with some of 9 the -- the literature. It wasn't something that I 10 focused on, you know -- 11 Q Or you were asked to do. 12 A -- or opined about in my report. So, I 13 know some things, but I didn't prepare in depth on 14 that topic for this deposition. 15 Q Nor have you offered an opinion on it? 16 A No. 17 Q Do you plan to offer an opinion on it? 18 MR. FROST: Objection to form. 19 THE WITNESS: Not really, but I guess it 20 depends on what you ask me, the nature of the 21 questions, if there are further questions on that. 22 BY MR. BURNS: 23 Q What about any other heavy metals in the 24 J&J talc -- 25 MR. FROST: Objection.</p>	<p style="text-align: right;">Page 220</p> <p>1 opinion as to the presence or absence of any of 2 those minerals? 3 A Well, again, they're -- they're trace 4 elements that I know have been documented, but, 5 you know, again, I don't have it in my head 6 what -- what those concentrations are or the 7 details of the distribution. So I'm not -- I'm 8 not ready today to -- to comment on that for you. 9 Q And you haven't been asked to. 10 A No, I have not been asked to, no. 11 Q Okay. If you'd go back to Exhibit 1, 12 your report, Dr. Webb. 13 And I realize the level of detail on 14 page 17 in -- in Figure 9 makes this difficult. 15 First of all, did the mineral codes or 16 rock codes vary across maps, or can they vary? 17 MR. FROST: Objection to form. 18 THE WITNESS: Each of the different 19 colored or patterned units here is a different -- 20 is a different rock unit. So, yes, there's a 21 distribution of different rock types here in 22 this -- 23 BY MR. BURNS: 24 Q Well, by that I mean -- let's see, this 25 map was taken from --</p>
<p style="text-align: right;">Page 219</p> <p>1 BY MR. BURNS: 2 Q -- are you going to offer any opinion on 3 those? 4 MR. FROST: Objection to form. Assumes 5 there's any metals in the J&J talc. 6 THE WITNESS: Again, I -- I have some 7 general knowledge, but it's not literature that I 8 reviewed or summarized for here. So I don't feel 9 prepared to -- as we sit here today, to opine on 10 that. 11 BY MR. BURNS: 12 Q And just so I can close that loop, any 13 opinion as to the presence or absence of nickel? 14 MR. FROST: Same objections. 15 THE WITNESS: I mean, I would say 16 presence, yes. At what levels is where the devil 17 in the details is, so -- and I can't quote you 18 parts per million or parts per billion here, 19 but -- 20 BY MR. BURNS: 21 Q Same question with respect to cobalt? 22 A Same answer. 23 Q Chromium? 24 A Similar answer, yeah, and, again, I'm -- 25 Q But you're not prepared to offer an</p>	<p style="text-align: right;">Page 221</p> <p>1 A It's Ratcliffe, et al., 2011. 2 Q 2011. Okay. Which was a GS -- USGS 3 map, right? 4 A (The witness nods.) 5 Q And have you cited or described any 6 non-USGS maps in your report? 7 A Well, I mean -- well, Karabinos -- not a 8 specific map -- well, actually, there are -- in 9 Karabinos, et al., 2010, I talk about the 10 isograds. Again, the -- the lines that you would 11 draw on the map that delineate boundaries between 12 rocks that have experienced the same pressure 13 temperature conditions during a metamorphic event. 14 Q Okay. And what I'm really getting at 15 are -- is not necessarily the separation into 16 different codes, but the codes themselves that are 17 used for rocks that are relevant to your analysis. 18 Can those vary across maps, meaning between the 19 USGS maps and the other map you just described? 20 A Oh, they might. 21 MR. FROST: Objection to form. 22 BY MR. BURNS: 23 Q Do you recall offhand the specific rock 24 codes that you viewed as relevant to your analysis 25 in this particular case?</p>

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<p style="text-align: right;">Page 222</p> <p>1 A I believe the -- I'd have to look at</p> <p>2 the -- the map -- the map index to really confirm,</p> <p>3 but I believe that the ultramafics here are the</p> <p>4 CZU, and that, in general -- I mean, the -- the</p> <p>5 country rocks that host those bodies are -- that's</p> <p>6 the Mooretown information, but the -- O something.</p> <p>7 I -- yeah, sorry, I don't have the code memorized.</p> <p>8 Q Okay. Are you familiar with any reports</p> <p>9 of mass fibers, mass asbestos fibers in Vermont</p> <p>10 talc deposits?</p> <p>11 A No.</p> <p>12 Q Are mass fibers relatively rare?</p> <p>13 A Yes.</p> <p>14 Q Where do they typically occur?</p> <p>15 A Well, I know they've been documented at</p> <p>16 Belvidere Mountain. And also out in California</p> <p>17 in -- I'm not going to be able to remember the</p> <p>18 name of the -- of the body. But it's, yeah, in</p> <p>19 limited instances and much rarer occurrences than</p> <p>20 the cross and slip fiber occurrences.</p> <p>21 Q Okay.</p> <p>22 MR. BURNS: We have a couple of</p> <p>23 documents that we had pulled out that we need to</p> <p>24 figure out what to do with. You want to mark</p> <p>25 these individually or wait till we mark the --</p>	<p style="text-align: right;">Page 224</p> <p>1 and not by Dr. Webb, although they hopefully</p> <p>2 approximate her reliance materials.</p> <p>3 MR. FROST: Yep, that's fair, and</p> <p>4 that -- that's a fair statement of the agreement</p> <p>5 we reached.</p> <p>6 MR. BURNS: All right. Great. Thanks,</p> <p>7 Mr. Frost.</p> <p>8 BY MR. BURNS:</p> <p>9 Q So we will mark that box Exhibit 15.</p> <p>10 There are a couple of documents, Dr. Webb, that</p> <p>11 we're just trying to figure out what they are,</p> <p>12 frankly, and we'll mark those as 15A and 15B.</p> <p>13 (Webb Exhibit Nos. 15, 15A and 15B</p> <p>14 were marked for identification.)</p> <p>15 BY MR. BURNS:</p> <p>16 Q And I'll hand you 15A first.</p> <p>17 There's 15B. B as in boy.</p> <p>18 A I would want to confirm this, but my</p> <p>19 first impression is, is that this is from the</p> <p>20 spreadsheet that is part of Van Gosen 2006.</p> <p>21 Q And that's referring to Exhibit 15A, is</p> <p>22 it not?</p> <p>23 A Yes. 15A, yes.</p> <p>24 So I believe, you know, if you go to the</p> <p>25 site, the USGS site from which you can download</p>
<p style="text-align: right;">Page 223</p> <p>1 MS. O'DELL: Let's mark them</p> <p>2 individually.</p> <p>3 MR. BURNS: Okay. That may make --</p> <p>4 let's go off the record for a second.</p> <p>5 THE VIDEOGRAPHER: Going off the record</p> <p>6 at 5:35 p.m.</p> <p>7 (Recess.)</p> <p>8 THE VIDEOGRAPHER: We're back on the</p> <p>9 record at 5:43 p.m.</p> <p>10 BY MR. BURNS:</p> <p>11 Q Hello again, Dr. Webb.</p> <p>12 MR. BURNS: So, first of all, a bit of</p> <p>13 colloquy between counsel here. Defense counsel</p> <p>14 was kind enough this morning to bring in two</p> <p>15 boxes, which I believe were identical, of</p> <p>16 documents that defense counsel had put together</p> <p>17 that constitute what they believe to be, I think,</p> <p>18 the vast majority of your reliance materials with</p> <p>19 maybe the exception of Winter.</p> <p>20 MR. FROST: I think that's the only one</p> <p>21 we found was missing thus far.</p> <p>22 MR. BURNS: Thus far. So we have agreed</p> <p>23 to simply mark one of the boxes as Exhibit 15,</p> <p>24 with the stipulation that the box and its</p> <p>25 materials were gathered and prepared by counsel</p>	<p style="text-align: right;">Page 225</p> <p>1 the map that I talked about that plots presumable</p> <p>2 asbestos localities in Vermont, there are some</p> <p>3 supporting documents, and in those, yeah, was this</p> <p>4 list -- I mean, it was for all of New England, but</p> <p>5 this is the sheet that's specific to Vermont, and</p> <p>6 it gives the latitude, longitude. And then this</p> <p>7 is the list of references that I said that I tried</p> <p>8 to dig into on my own to confirm those</p> <p>9 occurrences.</p> <p>10 Q Okay. So just to be clear, 15A is not a</p> <p>11 document that you believe you prepared; is that</p> <p>12 right?</p> <p>13 A Oh, yeah. No, I didn't prepare this. I</p> <p>14 think we could go and download the Excel file off</p> <p>15 the USGS website, and this is what would be in</p> <p>16 that.</p> <p>17 Q I see.</p> <p>18 MR. BURNS: And you can let us know with</p> <p>19 an errata, I would assume, if that's not -- not</p> <p>20 the case.</p> <p>21 MR. FROST: Yeah, we'll confirm that.</p> <p>22 MR. BURNS: Okay.</p> <p>23 THE WITNESS: And I'm not sure, because</p> <p>24 when I went into the references, I went into the</p> <p>25 list that was specific to Vermont that's shown</p>

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<p>1 here in 15A.</p> <p>2 My guess is that this is the -- the list</p> <p>3 of references that accompanied the -- the map more</p> <p>4 directly. So this would include -- again, this</p> <p>5 particular report was asbestos in New England or</p> <p>6 the northeastern United States, so he had these</p> <p>7 spreadsheets specific to each state. And then I</p> <p>8 think this is the -- a compilation of all these</p> <p>9 for -- for all of the sites that -- but, again,</p> <p>10 I -- we'd have to -- we should be able to download</p> <p>11 this from that same website, the USGS site.</p> <p>12 BY MR. BURNS:</p> <p>13 Q Thank you, Dr. Webb.</p> <p>14 MR. BURNS: And I guess we'll just</p> <p>15 confirm that.</p> <p>16 MR. FROST: Yes. Same thing, if we</p> <p>17 confirm something different, we'll mark it in the</p> <p>18 errata sheet.</p> <p>19 MR. BURNS: Okay. Thank you.</p> <p>20 So do we have a standalone one like</p> <p>21 this?</p> <p>22 MS. O'DELL: No, that's all we have.</p> <p>23 MR. BURNS: Okay. Let's make sure we've</p> <p>24 got -- this one is marked, so we probably want to</p> <p>25 make sure that there's a clean version in the</p>	<p>1 (Webb Exhibit No. 15C was marked</p> <p>2 for identification.)</p> <p>3 BY MR. BURNS:</p> <p>4 Q Okay. Dr. Webb, we have handed you</p> <p>5 Exhibit 15C, C as in Charlie.</p> <p>6 Is this the English translation of the</p> <p>7 Chinese article that we were looking at earlier?</p> <p>8 A I believe so, yes.</p> <p>9 Q Okay. Now, in looking through this --</p> <p>10 and this was an article on which you relied in</p> <p>11 rendering your opinions with respect to the</p> <p>12 Chinese mines; is that right?</p> <p>13 A I did, yes.</p> <p>14 Q Okay. Now, in terms of the orogen of</p> <p>15 the talc in those mines, is it fair to say that</p> <p>16 the -- that the orogen of the talc was in part</p> <p>17 tremolite existing in the region?</p> <p>18 A I'm sorry, I don't -- I don't understand</p> <p>19 the question.</p> <p>20 Q Sure.</p> <p>21 Let me just turn you to page -- well,</p> <p>22 there's a page -- let's see.</p> <p>23 A I'll work with you.</p> <p>24 Q Four pages before the end.</p> <p>25 A Okay. So this one with the --</p>
Page 227	Page 229
<p>1 actual Exhibit 15 box.</p> <p>2 MR. FROST: What document is this,</p> <p>3 Leigh?</p> <p>4 MR. BURNS: This is the English</p> <p>5 translation.</p> <p>6 MR. FROST: Yes, that's definitely not</p> <p>7 in the box.</p> <p>8 MR. BURNS: Oh, it's not?</p> <p>9 MS. O'DELL: I found it in the box.</p> <p>10 MR. FROST: Oh, you did find it in the</p> <p>11 box? Oh, okay.</p> <p>12 MS. O'DELL: It was a few tabs after --</p> <p>13 MR. FROST: I see. You had -- yeah, I</p> <p>14 did it too, Laura. Let's see if we can find a</p> <p>15 clean copy.</p> <p>16 MR. BURNS: Thank you.</p> <p>17 MR. FROST: You don't happen to know the</p> <p>18 number, do you?</p> <p>19 MR. BURNS: Leigh.</p> <p>20 (A discussion was held off the record.)</p> <p>21 THE VIDEOGRAPHER: Going off the record</p> <p>22 at 5:48 p.m.</p> <p>23 (A discussion was held off the record.)</p> <p>24 THE VIDEOGRAPHER: Back on the record at</p> <p>25 5:50 p.m.</p>	<p>1 Q That's it, I think.</p> <p>2 And perhaps I wasn't precise enough or</p> <p>3 didn't use the right terminology, but if we walk</p> <p>4 through this page, I think you'll see where I'm</p> <p>5 going.</p> <p>6 So the article refers to the mother rock</p> <p>7 that is directly related to mineralization is</p> <p>8 dolomite marble. Do you see that?</p> <p>9 A Yes.</p> <p>10 Q And by "mother rock," that would be the</p> <p>11 rock that was changed ultimately to talc?</p> <p>12 A Yeah, so in my report that's the</p> <p>13 protolith.</p> <p>14 Q Okay. The protolith.</p> <p>15 Now, it goes on to say: "This formation</p> <p>16 contains 19 percent magnesium oxide in this zone,</p> <p>17 so the requirement for generating the talc ore</p> <p>18 deposit cannot be completely satisfied, and</p> <p>19 magnesium oxide must be absorbed from the external</p> <p>20 surrounding rock to supplement, and the</p> <p>21 surrounding rock that satisfies this formation</p> <p>22 condition is spilite." Is that right?</p> <p>23 A Yes.</p> <p>24 Q It goes on to say: "In this zone, the</p> <p>25 content of MGO in spilite is 8.14 percent on</p>

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<p style="text-align: right;">Page 230</p> <p>1 average. Through rock-mineral determination and 2 analysis, magnesium oxide is mainly concentrated 3 in the tremolite, the content" -- parentheses, 4 "the content of tremolite in spilite is 30 to 5 35 percent." 6 Is that correct? 7 A Yes. 8 Q Okay. So in this case, would the 9 tremolite existing in the spilite also be 10 considered a protolith to the talc? 11 A Well, it's part of the metasomatic 12 process. So what he describes here is, again, 13 that there is diffusion of chemicals, of elements 14 across the rock boundaries. And what he said is 15 that basically if you look at the mass balance, 16 you can't just form the talc that's present solely 17 by the chemistry of the -- the dolomite alone. So 18 that there was diffusion of magnesium across the 19 rock boundary from the -- the spilite into the 20 dolomite. 21 So, no, I mean, the protolith is still 22 the -- the carbonate rock, but the magnesium 23 that's ultimately in the talc, some percentage of 24 that diffused from the -- the spilite. 25 Q Which the source of that magnesium was</p>	<p style="text-align: right;">Page 232</p> <p>1 A Yes. 2 Q And that magnesium -- would that 3 magnesium oxide have been contributed from the 4 tremolite to form the -- to form the talc by -- 5 actually, strike that. 6 Why don't I just ask you this question: 7 How would the tremolite contribute that magnesium 8 oxide to the formation of the talc ore? 9 A There would be, I mean, a metamorphic 10 reaction. So -- and, actually, I think he 11 describes this in here. I'd have to again kind of 12 look at this in -- in more detail, but -- but 13 basically the tremolite is -- is reacting -- well, 14 undergoing a chemical reaction where the magnesium 15 is liberated, and so then you're going to have 16 residual silicon dioxide and also calcium, and 17 some of that calcium I believe is contributing to 18 the formation of -- of carbonate, of calcite in 19 this case. 20 So the tremolite that does break down is 21 no longer there. The magnesium went into the 22 talc, in the talc ore, and the residual calcium 23 and silica probably formed quartz and calcite. 24 Q Okay. Is it possible that the remaining 25 tremolite could have been interspersed with the</p>
<p style="text-align: right;">Page 231</p> <p>1 the tremolite in the spilite, correct? 2 A Yeah, that was the -- the 3 magnesium-bearing mineral in the spilite, yes. 4 Q Okay. And the tremolite -- content of 5 the tremolite and spilite was 30 to 35 percent, 6 correct? 7 A Yes, that's what it says. 8 Q Is it possible that -- excuse me -- is 9 it possible that tremolite was not fully 10 assimilated into the resulting talc such that 11 tremolite remains in the talc ore? 12 MR. FROST: Objection to form, misstates 13 document. 14 THE WITNESS: Such that tremolite -- 15 what was the last part? 16 BY MR. BURNS: 17 Q Remains in the talc ore. 18 A I think you mean remains in the spilite? 19 Q Well, what I'm getting at is some 20 percentage of the magnesium would have come from 21 the -- from the talc or from the tremolite -- let 22 me strike that. 23 Some percentage of the magnesium oxide 24 would have come from the tremolite in the spilite, 25 correct?</p>	<p style="text-align: right;">Page 233</p> <p>1 talc ore? 2 A Yeah, I don't -- I don't think so. It 3 seems that they describe -- the boundaries are 4 still pretty -- pretty clear. So -- but again, 5 you know, I wouldn't be surprised if there was a 6 little bit of tremolite maybe in with the -- the 7 talc, but that doesn't mean anything in -- you 8 know. 9 Q Without further question. 10 A Yeah, I mean, you know, my -- the 11 default would always be that it's prismatic 12 tremolite or, again, maybe acicular tremolite or 13 ablated tremolite, but this is not a recipe for 14 making tremolite asbestos. 15 Q Why would that always be the default? 16 A Because asbestos is so rare. I mean, 17 I've seen tremolite in a lot of rocks, but I've 18 never seen tremolite asbestos in -- again, in my 19 own studies, and that -- you know, and most people 20 haven't. You know, there's basically -- what are 21 the statistics I quoted in my report? That of the 22 amphiboles present in rocks in the continental 23 crust, less than 1 percent by volume, I think, are 24 asbestiform. 25 And so, you know, it really takes</p>

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<p style="text-align: right;">Page 234</p> <p>1 special conditions, a special situation to create 2 that, and what is described here is not -- 3 Q What percent -- 4 A -- anything that leads me to believe 5 that this resulted in tremolite asbestos. 6 Q What percentage of the crust do 7 amphiboles make up? 8 A They're the fifth most common mineral 9 generally in the continental crust, and, I mean, 10 it depends on where you are. I think, you know, 11 it's maybe -- let me check because I wrote 12 something about this. I don't want to misspeak. 13 So in the coterminous United States by 14 area, 6 to -- 6 to 10 percent of the rock types 15 exposed at the surface are amphibole bearing. 16 Q And so 1 percent of that 6 to 10 percent 17 would be asbestiform? 18 A Or less than 1 percent by volume of -- 19 of all amphiboles, yes. 20 Q That would still be a pretty significant 21 volume of rock, though, would it not? 22 MR. FROST: Objection to form. 23 THE WITNESS: Yeah, but it -- again, it 24 takes special conditions. So where asbestos is 25 formed, it's well documented by multiple</p>	<p style="text-align: right;">Page 236</p> <p>1 or I was familiar with many, but -- 2 Q Did you look up Robert Virta, 1985, 3 Bureau of Mines? 4 A I have seen that. 5 Q Okay. Do you recall reading it? 6 A Yeah. Can -- actually, can we see the 7 exact citation, because I just want to -- 8 Q I think we could mark it. Right? 9 (Webb Exhibit No. 16 was marked 10 for identification.) 11 MR. FROST: Are we on 17? 12 MS. KLEVORN: 16. 13 MR. BURNS: 16, yep. 14 MR. FROST: That's right, because you 15 marked everything as A, B or C, right? 16 Thank you. 17 THE WITNESS: Uh, I -- I believe I have 18 seen this, but, again, it really wasn't of -- of 19 interest because it's from New York. So it didn't 20 pertain directly to the petrology of -- of the 21 mines of interest. 22 BY MR. BURNS: 23 Q Do you recall there being references to 24 talc mines within this document? 25 A I really have to read it again, because,</p>
<p style="text-align: right;">Page 235</p> <p>1 instances, and it -- you know, it's rare. I -- 2 just, you know, I wouldn't -- I would never expect 3 if someone says tremolite or actinolite that they 4 mean actinolite or tremolite asbestos unless 5 it's -- that is specified in -- in those words, 6 asbestiform. 7 MR. BURNS: Can we just go off the 8 record for a minute? 9 THE VIDEOGRAPHER: Going off the record 10 at 6:00 p.m. 11 (Recess.) 12 THE VIDEOGRAPHER: We're back on the 13 record at 6:07 p.m. 14 BY MR. BURNS: 15 Q Dr. Webb, I believe you testified that 16 you had reviewed Drs. Cook and Krekeler's reports; 17 is that correct? 18 A Yes. 19 Q Okay. Now, did you review all of the 20 reliance materials that were listed in those 21 reports? 22 A Well, for -- particularly for the 23 petrology related piece that I was specifically 24 interested in, I did look up some of their 25 citations. I wouldn't say all of them necessarily</p>	<p style="text-align: right;">Page 237</p> <p>1 again, I didn't -- I didn't review it in 2 preparation for today. I -- I don't believe it 3 was on my reliance either. 4 Q Okay. So this had -- you don't recall 5 this report having any impact on your opinions. 6 Is that correct? 7 A Yeah, I mean -- again, I mean, the 8 samples are specific to the Gouveneur mine in New 9 York state. So -- no, it didn't -- it didn't feed 10 into my -- the opinions I presented in my report. 11 Q Okay. What about Charles Ratte, 1982? 12 A Yes, I've seen that. The state 13 geologist report? 14 Q Right, the state geologist of Vermont, 15 correct? 16 A Yes. 17 Q Did you review that report before -- 18 A I -- 19 Q I'm sorry, go ahead. 20 A No. 21 Q Did you review that report prior to 22 rendering your opinions? 23 A Yes. 24 Q And did it impact your opinions at all? 25 MR. BURNS: Let's go ahead and mark it.</p>

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<p style="text-align: right;">Page 238</p> <p>1 THE WITNESS: I don't think it was a --</p> <p>2 a key player. I think I saw some things in there</p> <p>3 that seemed inconsistent with other data, and --</p> <p>4 but, again, the details I don't have in my head.</p> <p>5 (Webb Exhibit No. 17 was marked</p> <p>6 for identification.)</p> <p>7 BY MR. BURNS:</p> <p>8 Q Is that the report you reviewed?</p> <p>9 A Yes. I recognize this, yeah.</p> <p>10 Q And we've marked that as Exhibit 17.</p> <p>11 Okay.</p> <p>12 MR. BURNS: All right. We have no</p> <p>13 further questions.</p> <p>14 MR. FROST: Okay.</p> <p>15 CROSS-EXAMINATION</p> <p>16 BY MR. FROST:</p> <p>17 Q So, Laura, I apologize. Sitting next to</p> <p>18 you is just going to make this, you know, a little</p> <p>19 more awkward, but I'm going to ask you a couple of</p> <p>20 questions now.</p> <p>21 MR. FROST: Do you have Demonstrative 2,</p> <p>22 as you used it and marked it?</p> <p>23 THE WITNESS: I do.</p> <p>24 BY MR. FROST:</p> <p>25 Q You have -- you have Exhibit 2, I think.</p>	<p style="text-align: right;">Page 240</p> <p>1 this case?</p> <p>2 A No, it doesn't.</p> <p>3 Q What is the best and most complete</p> <p>4 statement of your opinions with the context</p> <p>5 necessary to understand them?</p> <p>6 A Well, that would be my expert report.</p> <p>7 Q And that's the document that was marked</p> <p>8 as Exhibit 1 today?</p> <p>9 A I believe so.</p> <p>10 Q And what is the best, most complete</p> <p>11 summary of your qualifications, knowledge,</p> <p>12 training and experience to render an opinion in</p> <p>13 this case?</p> <p>14 A Well, that would be my curriculum vitae.</p> <p>15 Q And do you recall going through and</p> <p>16 answering many of the questions -- or I guess all</p> <p>17 the questions that are in Demonstrative 2; is that</p> <p>18 correct?</p> <p>19 A Sorry, in this document?</p> <p>20 Q Yeah, you remember going through these?</p> <p>21 A Yeah. Yes.</p> <p>22 Q Do any of these questions and your</p> <p>23 answers to them affect your -- affect your ability</p> <p>24 to render an opinion here?</p> <p>25 A No.</p>
<p style="text-align: right;">Page 239</p> <p>1 A Oh, sorry.</p> <p>2 Q It's Demonstrative 2.</p> <p>3 A It shows you what I know about --</p> <p>4 Q I'm going to hand you what was</p> <p>5 previously marked as Plaintiffs' Demonstrative 2.</p> <p>6 MR. BURNS: Yeah, so we want to enter</p> <p>7 that into the record.</p> <p>8 MR. FROST: That's fine. We can mark</p> <p>9 that -- maybe we could mark it as Plaintiffs'</p> <p>10 Demonstrative 2 --</p> <p>11 MR. BURNS: Yeah. So all I was getting</p> <p>12 at, if you're going to mark a version, we</p> <p>13 should --</p> <p>14 MR. FROST: I'm not going to touch it.</p> <p>15 MR. BURNS: Okay.</p> <p>16 MR. FROST: No, I'm not going to mark it</p> <p>17 up. I just wanted to give it to her.</p> <p>18 MR. BURNS: Go ahead.</p> <p>19 BY MR. FROST:</p> <p>20 Q Do you remember this document from</p> <p>21 earlier today?</p> <p>22 A I do, yes.</p> <p>23 Q Okay. Does this demonstrative</p> <p>24 accurately reflect your qualifications, knowledge,</p> <p>25 training and experience to render an opinion in</p>	<p style="text-align: right;">Page 241</p> <p>1 Q Okay. I'm going to reach over if you</p> <p>2 don't mind.</p> <p>3 Here, sorry.</p> <p>4 Well, I will just show you my copies for</p> <p>5 purposes of what we're doing here. Okay.</p> <p>6 All right. Do you recall being shown</p> <p>7 earlier today various documents marked as</p> <p>8 Exhibit 12, Exhibit 13, and Exhibit 14?</p> <p>9 A Yes.</p> <p>10 Q Do you have those there?</p> <p>11 A Yes.</p> <p>12 Q Okay. Are any of these documents the</p> <p>13 type of documents that a petrologist would</p> <p>14 consider in undertaking a review of the geology</p> <p>15 and petrology of the geological formation?</p> <p>16 A No.</p> <p>17 MR. FROST: That's all the questions we</p> <p>18 have.</p> <p>19 MR. BURNS: Okay. Just a couple</p> <p>20 follow-up.</p> <p>21 REDIRECT EXAMINATION</p> <p>22 BY MR. BURNS:</p> <p>23 Q One, just so it's clear, why don't we</p> <p>24 mark as Exhibit 18 the --</p> <p>25 A The demonstrative?</p>

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<p style="text-align: right;">Page 242</p> <p>1 Q -- what I was calling Plaintiffs'</p> <p>2 Demonstrative 2, just so it's in the record.</p> <p>3 A It's now buried in the stratigraphy</p> <p>4 pile.</p> <p>5 MR. FROST: There it is.</p> <p>6 (Webb Exhibit No. 18 was marked</p> <p>7 for identification.)</p> <p>8 BY MR. BURNS:</p> <p>9 Q All right. You can put that over there.</p> <p>10 And finally, Dr. Webb, thank you for</p> <p>11 your time today. I did want to mark off that we</p> <p>12 did cover your report and opinions on Plaintiffs'</p> <p>13 Demo 1.</p> <p>14 MR. BURNS: All right. Thank you very</p> <p>15 much.</p> <p>16 MR. FROST: Great. Thank you, Warren.</p> <p>17 Thank you, Leigh and Amanda.</p> <p>18 THE VIDEOGRAPHER: This ends today's</p> <p>19 deposition.</p> <p>20 We're going off the record at 6:14 p.m.</p> <p>21 (Whereupon, the deposition of</p> <p>22 LAURA WEBB, Ph.D. was concluded</p> <p>23 at 6:14 p.m.)</p> <p>24</p> <p>25</p>	<p style="text-align: right;">Page 244</p> <p>1 INSTRUCTIONS TO WITNESS</p> <p>2 Please read your deposition over carefully and</p> <p>3 make any necessary corrections. You should state</p> <p>4 the reason in the appropriate space on the errata</p> <p>5 sheet for any corrections that are made.</p> <p>6 After doing so, please sign the errata sheet</p> <p>7 and date it.</p> <p>8 You are signing same subject to the changes</p> <p>9 you have noted on the errata sheet, which will be</p> <p>10 attached to your deposition. It is imperative</p> <p>11 that you return the original errata sheet to the</p> <p>12 deposing attorney within thirty (30) days of</p> <p>13 receipt of the deposition transcript by you. If</p> <p>14 you fail to do so, the deposition transcript may</p> <p>15 be deemed to be accurate and may be used in court.</p> <p>16</p> <p>17</p> <p>18</p> <p>19</p> <p>20</p> <p>21</p> <p>22</p> <p>23</p> <p>24</p> <p>25</p>
<p style="text-align: right;">Page 243</p> <p>1 CERTIFICATE OF CERTIFIED SHORTHAND REPORTER</p> <p>2 The undersigned Certified Shorthand Reporter</p> <p>3 does hereby certify:</p> <p>4 That the foregoing proceeding was taken before</p> <p>5 me at the time and place therein set forth, at</p> <p>6 which time the witness was duly sworn; That the</p> <p>7 testimony of the witness and all objections made</p> <p>8 at the time of the examination were recorded</p> <p>9 stenographically by me and were thereafter</p> <p>10 transcribed, said transcript being a true and</p> <p>11 correct copy of my shorthand notes thereof; That</p> <p>12 the dismantling of the original transcript will</p> <p>13 void the reporter's certificate.</p> <p>14 In witness thereof, I have subscribed my name</p> <p>15 this date: March 30, 2019.</p> <p>16</p> <p>17 _____</p> <p>18 LESLIE A. TODD, CSR, RPR</p> <p>19 Certificate No. 5129</p> <p>20</p> <p>21 (The foregoing certification of</p> <p>22 this transcript does not apply to any</p> <p>23 reproduction of the same by any means,</p> <p>24 unless under the direct control and/or</p> <p>25 supervision of the certifying reporter.)</p>	<p style="text-align: right;">Page 245</p> <p>1 -----</p> <p>2 E R R A T A</p> <p>3 -----</p> <p>4 PAGE LINE CHANGE</p> <p>5 _____</p> <p>6 REASON: _____</p> <p>7 _____</p> <p>8 REASON: _____</p> <p>9 _____</p> <p>10 REASON: _____</p> <p>11 _____</p> <p>12 REASON: _____</p> <p>13 _____</p> <p>14 REASON: _____</p> <p>15 _____</p> <p>16 REASON: _____</p> <p>17 _____</p> <p>18 REASON: _____</p> <p>19 _____</p> <p>20 REASON: _____</p> <p>21 _____</p> <p>22 REASON: _____</p> <p>23 _____</p> <p>24 REASON: _____</p> <p>25 _____</p>

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1 ACKNOWLEDGMENT OF DEPONENT
2 I, _____, do hereby
3 certify that I have read the foregoing pages, and
4 that the same is a correct transcription of the
5 answers given by me to the questions therein
6 propounded, except for the corrections or changes
7 in form or substance, if any, noted in the
8 attached Errata Sheet.
9

10 _____
11 LAURA WEBB, Ph.D. DATE
12
13

14 Subscribed and sworn to
15 before me this
16 _____ day of _____, 20____.
17 My commission expires: _____
18 _____

19 Notary Public
20
21
22
23
24
25

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Exhibit G



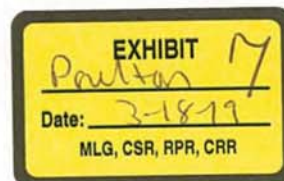
REPORT OF ITALIAN MINE

SAMPLES

J. & J.

DEPARTMENT OF
MINERAL EXPLOITATION

UNIVERSITY COLLEGE
CARDIFF



This document represents the completion
report of the Italian mine samples and
other powders supplied by Johnson and
Johnson, Cosham, Portsmouth, to the
Department of Mineral Exploitation.

The persons involved in the examination
of the material reported here were:

Mr. J. Lightfoot
Mr. G.A. Kingston
Dr. F.D. Pooley

REPORT OF INVESTIGATION OF ITALIAN MINE
SAMPLES AND RELATED POWDERS

Introduction

Talc is hydrated magnesium silicate ($Mg_3Si_2O_{10}(OH)_2$) which can occur in a number of forms. In its compact form it is known as steallite or soapstone. The form normally employed for toilet purposes is soft and very friable in character. It is mined in many parts of the world including the U.S.A., Canada, France, Italy, Norway and India, as well as several other countries. It occurs in both a flaky and lath like form and the chief deposits occur in altered magnesia-rich calcareous rocks such as dolomite, marble, and magnesian limestone. The purest talc deposits occur in association with dolomite and marble. Talc also occurs in altered basic rocks such as serpentines and again as thin beds in mica schists. Commercial talcs contain a number of related mineral impurities. They may include antigorite (hydrated magnesium silicate) magnesite or members of the magnesite-chalybite series of carbonates, dolomite (calcium magnesium carbonate), tremolite and actinolite (calcium, iron magnesium silicates), chlorites (magnesium aluminium iron silicates) and other minor minerals such as the sulphides and spinels.

The hand specimens examined in this report were collected at the Italian mine and do not represent an average collection of specimens of material being produced at the mine. The specimens were collected with the intention of sampling those areas with obvious non talc mineral inclusions. Specimens were retained which showed differences in physical appearance, i.e. fibrous, flakey, massive and powdery in texture. Specimens of ore in which colour variation was observed were also collected. In general the colour of the talc ore varied from grey through white to a light green colour. Obvious inclusions in the talc ore itself were retained and a careful search at the various sample locations in the talc seam was performed for fibrous amphibole minerals.

Specimens of the hanging and footwall were also collected to assess their mineral content as these were likely sources of ore contamination, although the method of mining which consisted of hand filling methods precluded any gross contamination of the ore.

The hand specimens have been, where possible, prepared for examination by the optical microscope and both polished blocks and thin sections of material have been employed. Representative fractions of all hand specimens have been reduced to powder form and subjected to powder X-ray diffraction examination. The representative powdered samples also form the samples for morphological examination by the electron microscope.

The list of samples obtained from the Italian mine are given in Tables 1 and 2 and throughout this report the samples are referred to by the preceding code number for each specimen.

The objective of the examination has been mainly to establish the major minerals which occur in association with talc at the Italian mine. In particular to look at the association of these minerals with the talc and especially those minerals which are of the same family as the commercial asbestos minerals, i.e. the amphiboles and serpentines.

The objective of the optical examination has been to establish textural and mineral relationship and not to quantify the phases occurring in each hand specimen. X-ray work has been aimed at establishing the minerals observed by optical means and to produce reference patterns for future investigation together with computed data from pattern measurement.

Electron microscope work has been selective in nature and performed on the finer fraction of the powdered specimens. Its aim has been to describe the morphology of the particles produced by comminution of the hand specimens and to investigate any obvious structural information which might be of use in identification of individual mineral particles.

Representative data obtained from the various examinations are included in the following report.

TABLE 1
LIST OF ITALIAN MINE SAMPLES

<u>Code No.</u>	<u>Description</u>
I.1.	Talc from footwall contact
I.2.	Sorting pieces (with obvious colour differences)
I.3.	Coloured talc (green)
I.4.	Face 10 sample with obvious amphibole inclusion.
I.5.	General ore
I.6.	Suspected Quartz sample
I.7.	Mica schist specimen
I.8.	Massive talc
I.9.	Grey talc 1st face
I.10.	Granular talc sample
I.11.	Carbonate and talc
I.12.	Footwall sample? Amphibolite
I.13.	Inclusion showing passage into talc bottom transit.
I.14.	Inclusion in talc seam face 4, middle of seam.
I.15.	Talc footwall contact
I.16.	Inclusion from face 1.
I.17.	Footwall rock sample
I.18.	Face 3 carbonate/talc sample
I.19.	Tremolite/quartz/talc sample
I.20.	Amphibole sample from Gianna level 1212
I.21.	Inclusion from face 2.
I.22.	Carbonate/talc sample
I.23.	Black gneiss 2 ft below talc seam
I.24.	Talc next to carbonate face 2.
I.25.	Footwall limestone
I.26.	Talc inclusions
I.27.	Lithological inclusions face 1

Table 1 Continued

<u>Code No.</u>	<u>Description</u>
I.28.	Quartz/talc sample
I.29.	Sample 6 footwall
I.30.	Quartz/Carbonate/talc sample
I.31.	Black inclusion face 1
I.32.	Face 2 inclusion from base of talc
I.33.	Talc from lower left end of working
I.34.	Marble/tunnel wall
I.35.	Massive carbonate from rear end of working
I.36.	Grey talc specimen
I.37.	Carbonate in talc inclusion
I.38.	Pyrite/talc specimen
I.39.	5" - 0 pieces from crusher
I.40.	Platey talc
I.41.	Face 2, good specimen
I.42.	Face 1, coloured green (talc)
I.43.	Face 10, fibrous sample
I.44.	Face 1, pure talc?
I.45.	Face 1, good specimen
I.46.	Face 3, coloured specimen

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TABLE 2

OTHER SPECIMENS EXAMINED

<u>Code No.</u>	<u>Description</u>
B1	Pure talc 1st face
B2	Greenish talc 1st face
B3	Talc 6 inches above footwall
B4	Talc from above inclusion
B5	Inclusion in talc
B6	Talc 2 ft above inclusion
B7	Section 2 ft above inclusion
B8	Pure talc 1st face
B9	Grey talc 1st face

Also examined

- 1) Batch shipments of ~~gypsum~~ talc
- 2) Old samples of British powders.

OPTICAL EXAMINATION OF SPECIMENS II - I46

Thin and polished sections were prepared of the specimens of wallrock and, where possible, the talc ore.

The minerals which formed a major constituent in at least one of the sections were quartz, muscovite, talc, chlorite, (var sheridanite), calcite, garnet, and tremolite; the latter only occurred as a major constituent in section II9. Phases which were always minor or accessory were microcline, plagioclase, biotite, pennine, epidote, clinozoisite, hornblende, actinolite (section I7), rutile, and opaque constituents pyrite, pyrrhotite, and chalcopyrite.

The identification of the minerals in the sections of these specimens was based on the optical characteristics of the minerals in transmitted and reflected light, both under plane polarised light (PPL) and crossed nicols (XN), combined with the results of the X-ray diffraction study of the crushed hand specimens. In some cases material was extracted from the sections and examined in R.I. liquids as in determining that the most common chlorite mineral in these specimens is a variety called sheridanite having a R.I. \pm equivalent of 1.590 ± 0.005 and a birefringence of $0.012 - 0.014$. Similarly much of the muscovite was nearly uniaxial with a R.I. of 1.600 corresponding to the variety phengite, an abnormally siliceous muscovite. In the case of talc its confident determination optically is difficult since its optical properties are identical to muscovite. However, it was found that the common "feathery" form of the talc combined with the invariable occurrence of minute transparent inclusions (suspected to be silica) in the talc producing a 'dusty' appearance in thin section and a greenish colour in hand specimen, enabled talc to be distinguished from muscovite. Talc also exhibited slightly higher order interference colours in general. Where talc was only an accessory mineral to muscovite, as in some of the wallrock samples, then it could not be distinguished with certainty.

In the following pages (no to) the Italian specimens are systematically described as regards their mineral composition and mode of intergrowth. Numerous photomicrographs taken under PPL and XN are provided with the description to mainly illustrate the rock textures which, it is hoped, will provide information useful in the comminution of particularly the talc ore samples, and also displays the non occurrence of asbestiform amphiboles in the talc ore.

Specimen 11

Specimen 11 consisted of several pieces of wallrock with one piece displaying the talc/footwall contact. One polished section was made of the talc/footwall contact and one thin section of the wallrock alone.

The wallrock is a schist which in thin section displayed a segregation of the main minerals into thin lenticular bands composed, as in Figure 1, of long tabular aggregates of intermixed muscovite (var. phengite) and chlorite (var. sheridanite), and granular quartz exhibiting a polygonal grain boundary structure. Accessory rutile occurs as orientated inclusions in the chlorite and muscovite, and also opaque constituents which in polished section were identified as dominantly pyrite metacrysts with minor pyrrhotite. Some subhedral porphyroblasts of plagioclase also occur.

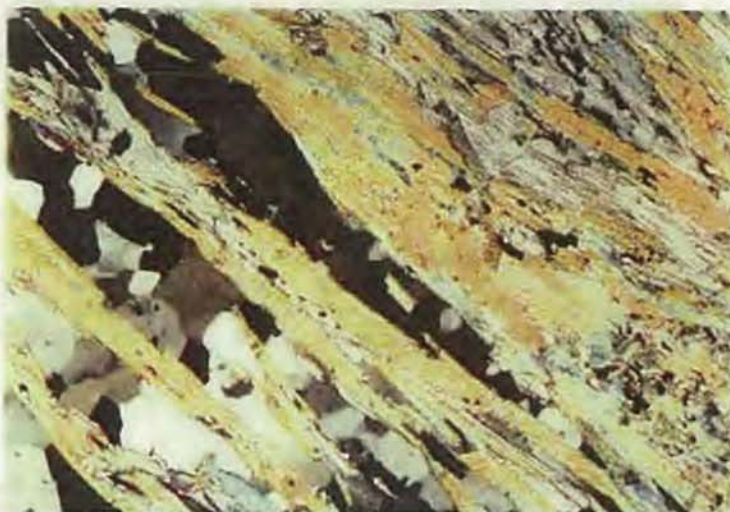


Fig. 1. Photomicrograph, X 40, of thin section of wallrock 11 under crossed nicols. A schist of quartz (granular white-black), muscovite (lamellar yellow-blue), and chlorite (lamellar white-blueish grey).

Specimen 13: 'coloured talc'

The minerals composing this specimen are major talc and chlorite (var. sheridanite) with the talc content much greater than chlorite, together with accessory garnet, rutile, and an unidentifiable finely dispersed phase occurring as minute transparent inclusions along the cleavage planes and grain boundaries of the talc and imparting a dusty brown appearance to the talc in thin section and a greenish colour in hand specimen. The talc occurs as medium grained feathery aggregates which are in places 'dusty' and grade into 'clean' transparent aggregates which are free of any inclusions. It appears that some retrograde metamorphic process has caused the inclusions to be removed or incorporated into the talc structure since single talc crystals display both types. The

minor chlorite is dispersed in the talc matrix as small lenticular and globular fibrous aggregates. Rare garnet, possibly a member of the ugrandite series because of its anisotropy, occurs as subhedral porphyroblasts.



Fig. 2. Photomicrograph, X 24, of thin section of 'coloured talc' specimen I3 under crossed nicols. Dominantly talc (yellow-blue interference colours) showing murky brownish black patches due to presence of fine unidentifiable inclusions.

Specimen I5: general ore

A coarse aggregate of curving foliaceous and feathery crystals of talc displaying evidence of shearing and translation twinning. As in specimen I3, dusty inclusions of a transparent mineral with a general prismatic habit occurs dispersed in the talc. As before, but to a lesser extent, the talc is cleansed of these inclusions along zones associated with deformation and translation twinning, and it appears that the inclusions have either been converted to talc (as in the conversion of tremolite to talc by low temperature CO₂ metasomatism) or incorporated into the talc structure as a result of retrograde deformation metamorphism. Rare small subhedral garnet porphyroblasts also occur.



Fig. 3. Photomicrograph, x 24, of thin section of 'general ore' specimen I5 under crossed nicols showing the texture of the talc, and the 'murky' inclusion-rich talc compared to the clear inclusion-free talc.

Specimen I6

Specimen I6 consists of a very coarse aggregate of interlocking anhedral magnesite grains which exhibit strongly irregular and angular penetrating grain boundaries. The magnesite is characterised in thin section, Fig. 3a, by its marked change in relief and perfect rhombohedral cleavage in plane polarised light, and very high order interference colours, Fig. 3b, under crossed nicols.

Intergranular pockets of fine grained foliaceous and radiating prismatic crystals of talc together with rare chlorite (var. sheridanite) occur. In places the prismatic clusters of talc appear to have formed at the expense of the magnesite, perhaps as a result of a retrograde thermal metamorphism with its formation being ascribed to a reaction between the magnesite and silica. One subhedral porphyroblast of plagioclase feldspar occurs in the thin section.



Fig. 3a. Photomicrograph, x 24, of thin section of specimen I₆ under plane polarised light, consisting dominantly of magnesite with minor talc and rare chlorite.

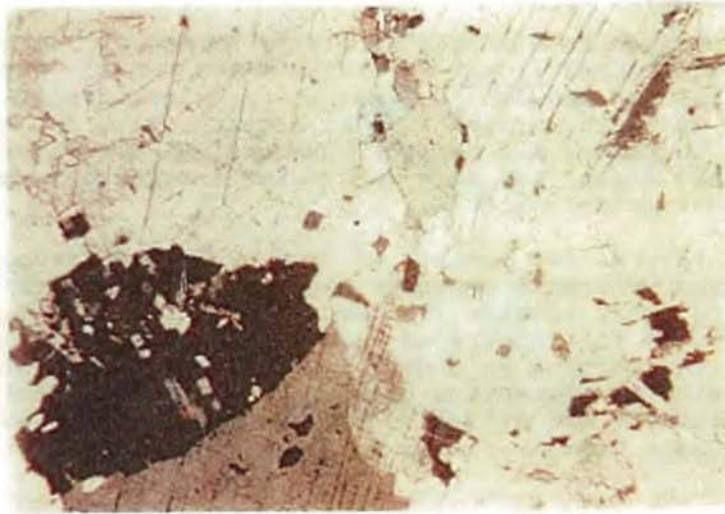


Fig. 3b. Photomicrograph of thin section of specimen I₆, mag x 24, under crossed nicols showing the occurrence of small equigranular and prismatic crystals of talc penetrating and interstitial to coarse anhedral magnesite.

Specimen I7

This specimen of wallrock is a quartz-muscovite-garnet schist (Figs. 4a, 4b, and 4c) containing some accessory actinolite, brown hornblende, talc and rare biotite.

The muscovite (var. phengite) forms long lenticular bands showing a preferred orientation in a matrix of interlocked equigranular quartz grains displaying strongly irregular grain boundaries. Large euhedral porphyroblasts of garnet, forming one of the major phases, are dispersed throughout the rock.

Accessory subhedral tabular and rhombic sections of actinolite (colourless to bluish green pleochroism) occur orientated parallel to the schistosity. The actinolite also occurs as rims to euhedral grains of rhombic and tabular outline which may have originally been brown hornblende but now are pseudomorphed by what appears to be a mixture of talc, chlorite and residual hornblende. Some talc is present as small pockets within the muscovite layers but this identification is based on the form, the lower refractive index and the occurrence of dusty inclusions. The colour, birefringence etc. of the talc is otherwise the same as muscovite.

In polished section the main opaque accessory mineral is pyrrhotite occurring as subhedral laths lying parallel to the schistosity. Traces of chalcopyrite also occur, and some rutile rods mainly as inclusions in the garnet porphyroblasts.



Fig. 4a Photomicrograph of polished section of I7 showing pyrrhotite (white), garnet (light grey), and muscovite-quartz (darker grey). Very dark to black areas are pits in the surface.

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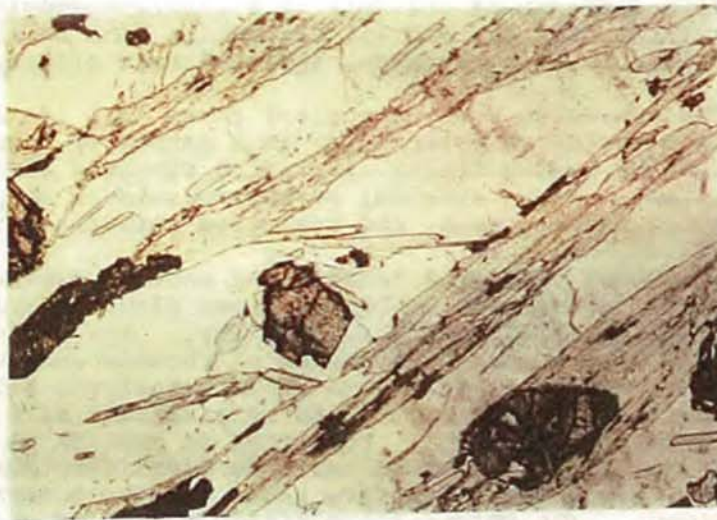


Fig. 4b. Photomicrograph, mag. x 40, of thin section of I7 consisting of garnet, muscovite and quartz under plane polarised light.



Fig. 4c. Photomicrograph, mag. x 40, of thin section of I7 under crossed nicols showing subhedral garnet (black), anhedral interlocking quartz (white-grey-black), and lamellar muscovite (coloured).

Specimen I₈

In hand specimen I₈ appears as a coarse aggregate of foliaceous talc varying in colour from white to greenish white. The general texture in thin section is of coarse foliated talc preferentially orientated and alternating with long lenses of a finer talc in which a preferred orientation appears to be absent as a result of shearing parallel to the schistosity. Minor chlorite (var. sheridanite) occurs as orientated laths intimately intergrown with the coarse talc and as fibrous aggregates in the finer talc lenses. Rare anhedral garnet, possibly pyrope, occurs.

In thin section the talc which appears greenish in hand specimen is seen to be crowded with minute inclusions of a pinkish mineral occurring as rounded to thin tabular grains and having a lower refractive index than the talc. A grey-brown amorphous material is also present. This material together with the granular inclusions is presumably responsible for the greenish colouration of the talc in hand specimen. As in I₃ and I₅ the greenish talc has been cleansed of inclusions along planes parallel to the schistosity by some later metasomatic process or retrograde metamorphic process. This 'absorption' of the inclusions by the talc or removal of the inclusions does not effect the form of aggregation of the talc crystals. Boundaries between the clean transparent and 'murky' talc often transgress the schistosity and there is no change in the coarseness or mode of aggregation of the talc across such boundaries. X-ray diffraction of the transparent white talc and the translucent greenish talc revealed no differences and the composition of these inclusions is at the moment unknown. Figure 5, under crossed nicols, shows such a transgressive boundary between the clear and 'murky' or dusty talc.



Fig. 5. Photomicrograph, mag x 24, of thin section I₈ showing the nature of the talc intergrowth under crossed nicols, and the transgressive boundaries between clear transparent talc and the inclusion-rich 'murky' talc which appears greenish white in hand specimen.

Specimen I₉: 'Grey talc 1st face'.

In specimen I₉ talc and chlorite (var. sheridanite) are the main constituents. They occur intimately intergrown as long orientated foliaceous aggregates alternating with finer platy aggregates in which the talc and chlorite fibres are randomly orientated and which form lenses elongated parallel to the schistosity of the coarser foliaceous talc (Figs. 6a and 6b). As in previous sections the talc appears murky in parts due to the presence of minute unidentifiable inclusions.

The talc is also crowded with small irregular and rod-shaped grains of rutile. Rare subhedral porphyroblasts of garnet (possibly pyrope) also occur.

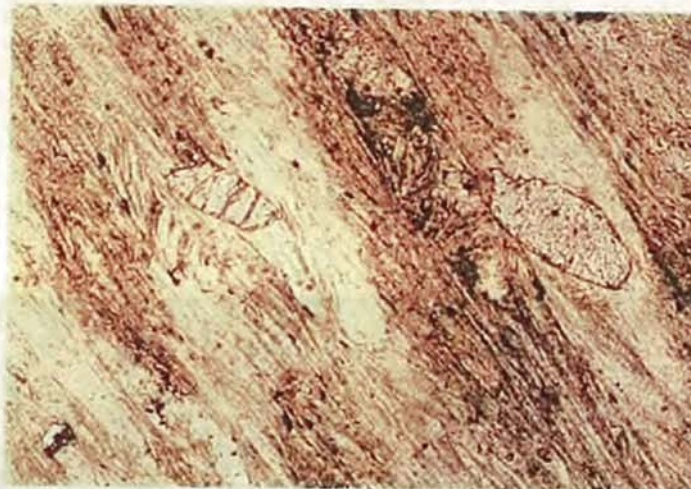


Fig. 6a Photomicrograph, x 40 mag, of thin section I₉ under plane polarised light showing subhedral garnet grains in an orientated foliaceous aggregate of talc and chlorite.



Fig. 6b. Photomicrograph, x 40 mag., of thin section Ig under crossed nicols showing garnet (black) in a coarse matrix of foliaceous talc (bright interference colours) and chlorite (white to blue-grey interference colours).

Specimen I₁₀ and I_{10A}: 'granular talc'

Both I₁₀ and I_{10A} consist of an intergrowth of medium grained and randomly orientated major talc with minor chlorite (var. sheridanite) (Fig. 7). Some small porphyroblasts of garnet also occur scattered in the talc/chlorite ground mass. In this specimen the talc is not crowded with inclusions as is the case in most of the other samples.

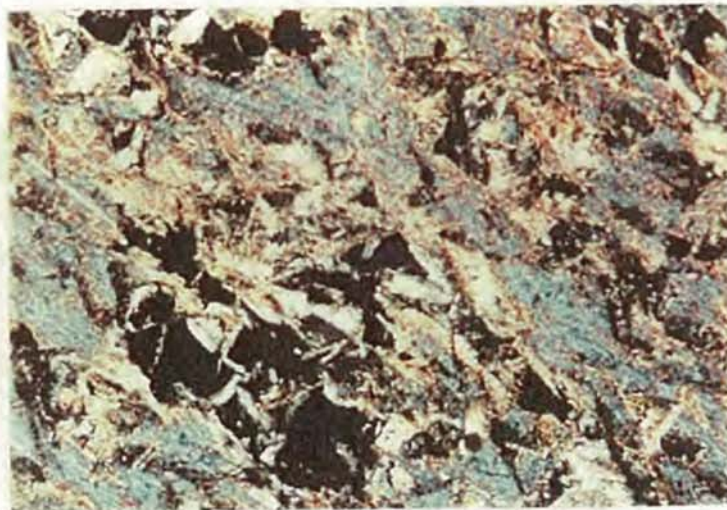


Fig. 7. Photomicrograph, x 40 mag., of thin section I₁₀, under crossed nicols, consisting of talc (blue and yellow interference colours), chlorite (white and greys), and garnet (black).

Specimen I₁₁ : 'carbonate and talc'

Specimen I₁₁ consists dominantly of a mosaic of coarse to fine grained anhedral interlocking magnesite grains with interstitial pockets of coarse to medium grained foliaceous aggregates of talc (Figs. 8a and 8b). The talc is crowded with near sub-microscopic inclusions of a transparent phase together with a brown amorphous material which causes the talc to appear dusty or turbid in thin section. Some fibrous chlorite (var. sheridanite) occurs as small pockets intergrown with the talc. Traces of rutile and pyrite occur.



Fig. 8a. Photomicrograph, x 24 mag., of thin section I11 under plane polarised light showing a subhedral pyrite metacryst (black) in a matrix of compact granular magnesite with interstitial foliaceous talc (top centre).



Fig. 8b. Photomicrograph, x 24 mag., of thin section I11 under crossed nicols showing a pyrite metacryst (black) in a granular magnesite matrix, with a foliaceous interstitial aggregate of talc (top centre).

Specimen I12

An aggregate of anhedral quartz as the main constituent with minor interstitial muscovite and green chlorite (var. pennine) Fig. 9. The long muscovite laths show a preferred orientation. Chlorite occurs in interstitial pockets as randomly orientated platy grains. Some epidote is present and a trace of magnesite.

The chlorite displays a pleochroism from light green to brownish-cream, and anomalous blue interference colours in some cases. However, most of the chlorite grains display lower second order to upper first order interference colours. Thus a range of chlorite composition is probably represented in the section.

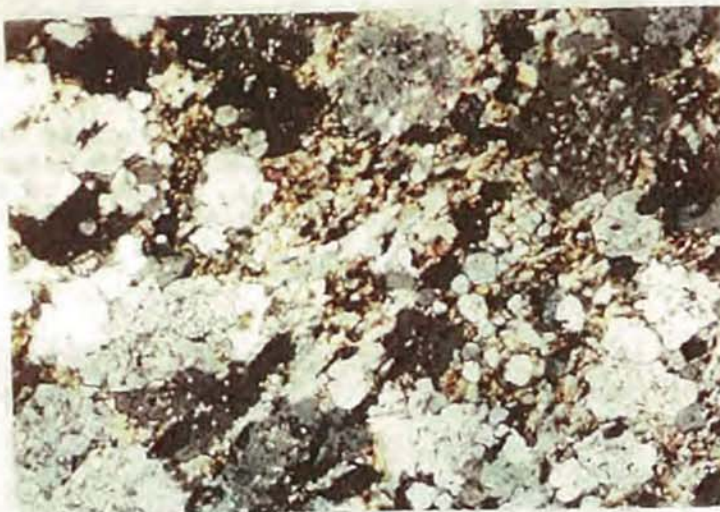


Fig. 9. Photomicrograph, x 40 mag., of thin section I12 under crossed nicols.

Specimen I13

This specimen consists of an aggregate of mainly medium grained platy to fibrous chlorite (var. sheridanite) and equigranular quartz. These two enclose ragged replacement residuals of calcite and subhedral metacrysts of pyrite with rare chalcopyrite.



Fig. 10a Photomicrograph, x 40 mag., of thin section I₁₃ under PPL showing subhedral pyrite meta-crysts (black) in a matrix of dominantly chlorite and quartz with minor calcite.



Fig. 10b Photomicrograph, x 40 mag., of thin section I₁₃ under XN showing chlorite (fibrous white and greenish-grey) and calcite (coloured) enclosing subhedral grains of pyrite (black). Equigranular grey grains are quartz.

Specimen I₁₄

This specimen is dominantly composed of very coarse grained magnesite enclosing minor amounts of talc and very minor chlorite (var. sheridanite). The talc and chlorite form pockets of radiating lamellar and foliaceous crystals as in Figs. 11a, 11b.



Fig. 11a Photomicrograph, x 24 mag., of thin section I₁₄ under PPL of coarse magnesite and intergranular pockets of 'dusty' and 'clear' talc.



Fig. 11b Photomicrograph, x 24 mag., of thin section I₁₄ under XN of magnesite (greenish) and pockets of radiating lamellar talc (blue, purple, yellow).

Specimen I15A

This specimen of wallrock is a garnet-muscovite-quartz schist with minor green chlorite, biotite, and rare talc and feldspar (Figs. 12a and 12b).

The garnet occurs as large (1-3mm diam.) porphyroblasts altered along irregular fractures to a mixture of greenish chlorite, biotite, and some feldspar, and enclosed in a matrix composed of orientated tabular grains of muscovite, forming elongated lenses, and alternating with 'mosaic' granular quartz containing randomly dispersed biotite and chlorite flakes.



Fig. 12a Photomicrograph, x 24 mag., of thin section I15A UNDER PPL showing a large altered porphyroblast of garnet in a matrix of dominantly muscovite with minor quartz.

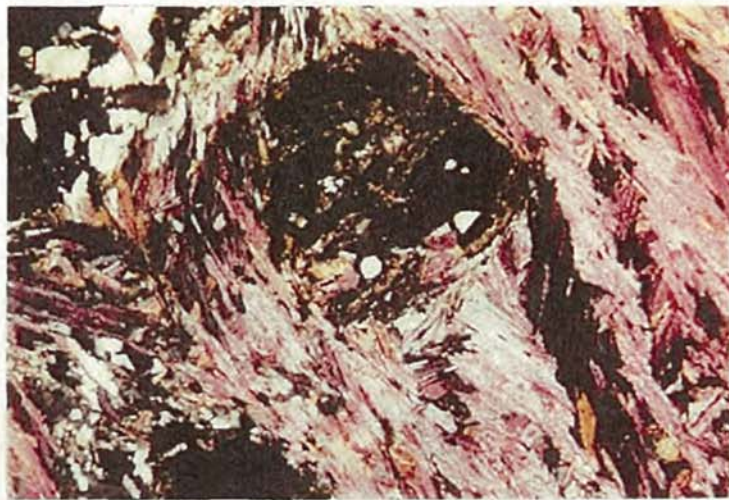


Fig. 12b. Photomicrograph, x 24 mag., of thin section I15A under crossed nicols. Garnet (black). Muscovite (dominantly purple interference colours). Quartz (white and greys).

Specimen I15

This specimen is dominantly composed of chlorite (var. sheridanite) and quartz as orientated aggregates producing a schistosity. Very minor amounts of magnesite and talc occur. The talc occurs as thin laths intergrown with the chlorite (Fig. 13b).



Fig. 13a Photomicrograph, x40 mag., of thin section I15 under PPL showing the irregular but preferred elongation of granular quartz segregations in a matrix of fibrous chlorite (var. sheridanite).

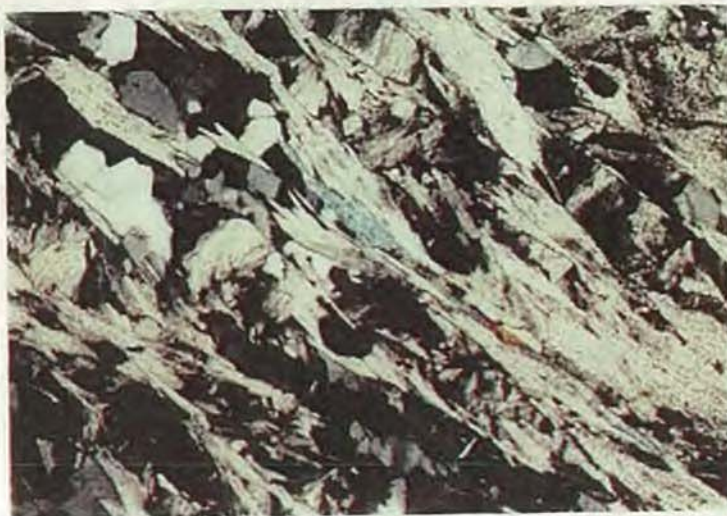


Fig. 13b Photomicrograph, x 40 mag., of thin section I15 under XM, composed of chlorite (fibrous white, greenish grey, black), quartz (granular white-grey-black), and talc (blue, red, and yellow interference colours).

Specimen I₁₆: 'first face inclusion'

This specimen is composed of a medium grained aggregate of dominantly chlorite (var. sheridanite) and quartz, with minor magnetite, clinozoisite, talc, and muscovite, and displaying a poor schistosity. Scattered euhedral to sub-hedral pyrite metacrysts occur as well as medium grained crystal aggregates of rutile associated with clinozoisite forming 'stringers' parallel to the general schistosity of the rock.

In the photomicrograph of figure 14a the brownish speckled areas are dominantly chlorite although in Figure 14b talc and muscovite are more apparent because of their interference colours.

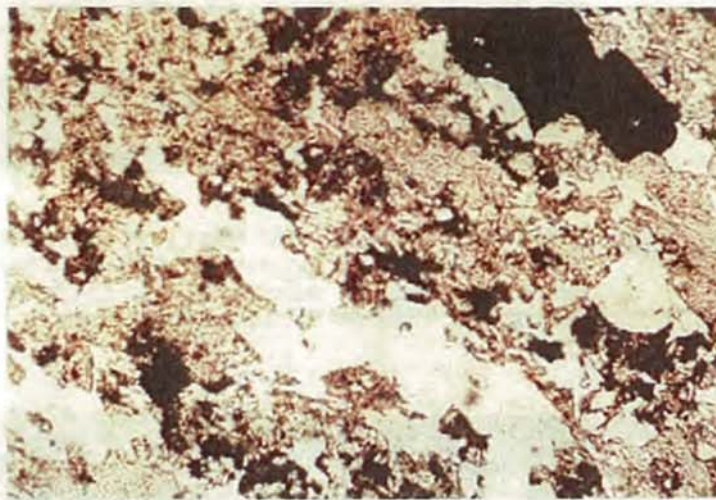


Figure 14a Photomicrograph, x 40 mag., of thin section I₁₆ under PPL.

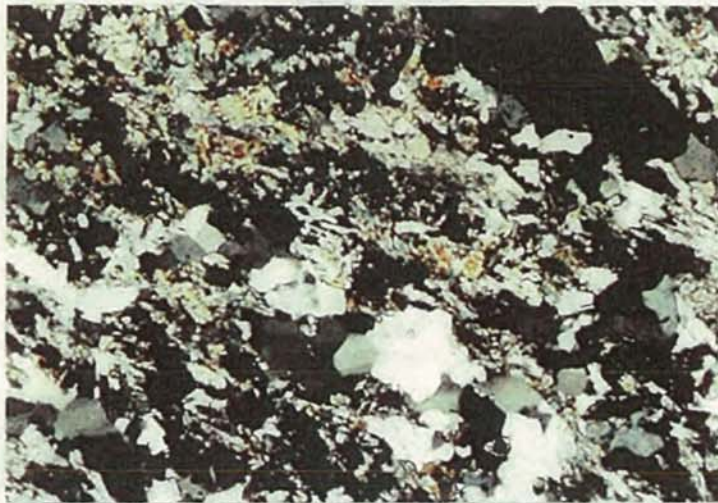


Fig. 14b Photomicrograph, x 40 mag., of thin section I16 under crossed nicols. A chlorite - quartz rock with minor talc and muscovite, and accessory magnesite, clinozoisite, rutile and pyrite.

Specimen I₁₇: 'footwall'

This specimen of footwall rock is a muscovite-quartz-garnet schist consisting of long lenticular anhedral quartz aggregates. Both are enclosing fractured and altered euhedral porphyroblasts of garnet. Accessory sphene also occurs as well as serpentine-quartz pseudomorphs after a mineral displaying rhombic and tabular sections.

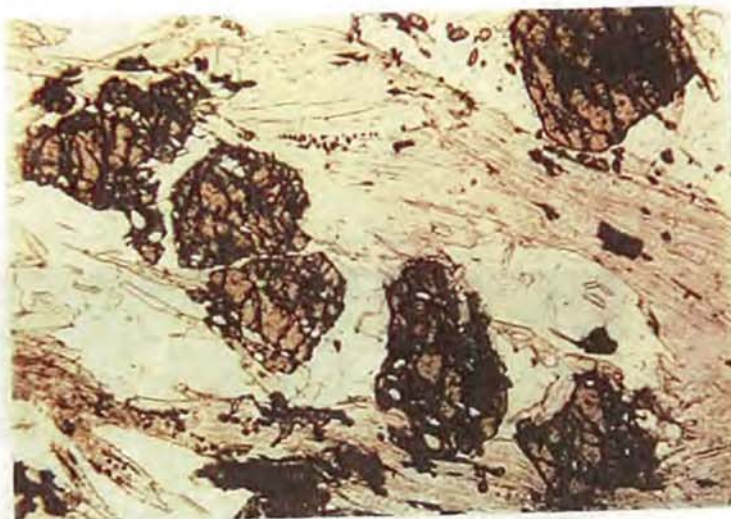


Fig. 15a Photomicrograph, x 24 mag., of thin section I₁₇ under PPL showing garnet euhedra in a matrix of segregated quartz and muscovite.



Fig. 15b Photomicrograph, x 24 mag., of thin section I₁₇ under XN. Garnet (black), quartz (white to grey), and muscovite (lamellar and coloured).

Specimen I₁₈: 'Face 3, carbonate/talc'

A coarse to medium grained aggregate of subhedral interlocking grains of magnesite with minor talc occurring as scattered small interstitial clusters associated with rare chlorite (var. sheridanite) and muscovite (Figs. 16a, 16b).

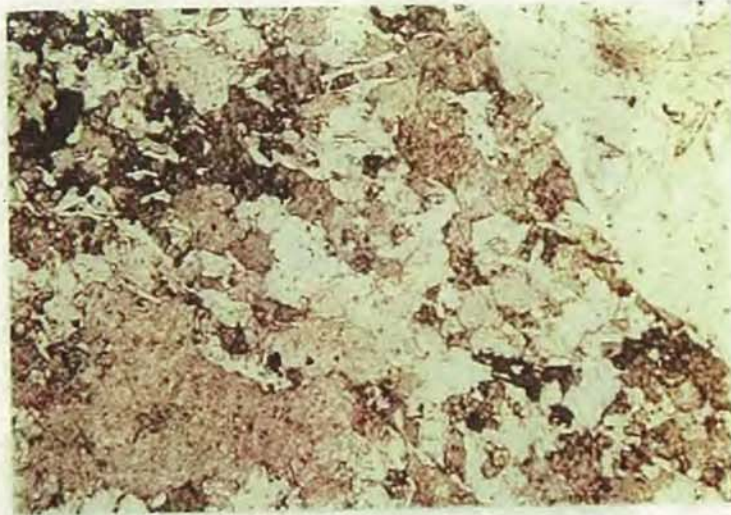


Fig. 16a Photomicrograph, x 24 mag., of thin section I₁₈ under PPL of granular magnesite with scattered tabular crystals and clusters of talc.

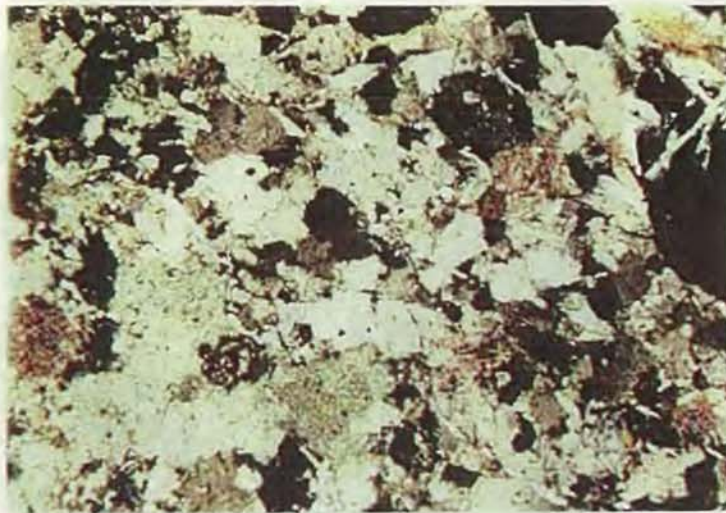


Fig. 16b Photomicrograph, x 24 mag., of thin section I₁₈ under XN of granular magnesite (high order interference colours, and scattered tabular crystals and clusters of talc (top right, coloured) and rare chlorite (white to blue-grey colours).

Specimen I₁₉:

This specimen consists of an aggregate of coarse grained anhedral magnesite intergrown with solitary bladed crystals and crystal aggregates of tremolite associated with minor amounts of fine fibrous talc and rare anhedral grains of quartz (Figs. 17a, 17b).

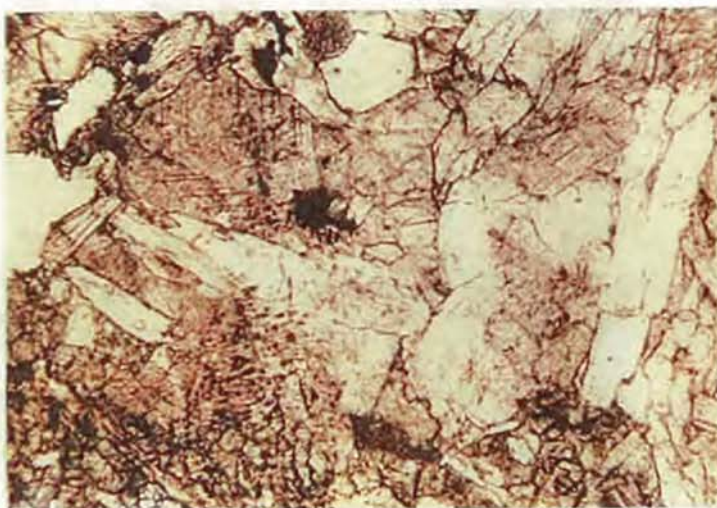


Fig. 17a Photomicrograph, x 24 mag., of thin section of I₁₉ under PPL, showing coarse bladed tremolite intergrown with very coarse grained magnesite.



Fig. 17b Photomicrograph, x 24 mag., of thin section I₁₉ under crossed nicols showing coarse bladed tremolite and anhedral coarse-grained magnesite with minor small fibrous aggregates of talc (top left).

Specimen I21: 'Inclusion, face 2'.

Specimen I21 is composed of a fine grained interlocking aggregate of anhedral magnesite, as the major constituent, associated with scattered laths and interstitial fine-grained fibrous aggregates of very minor talc (Figs. 18a and 18b).

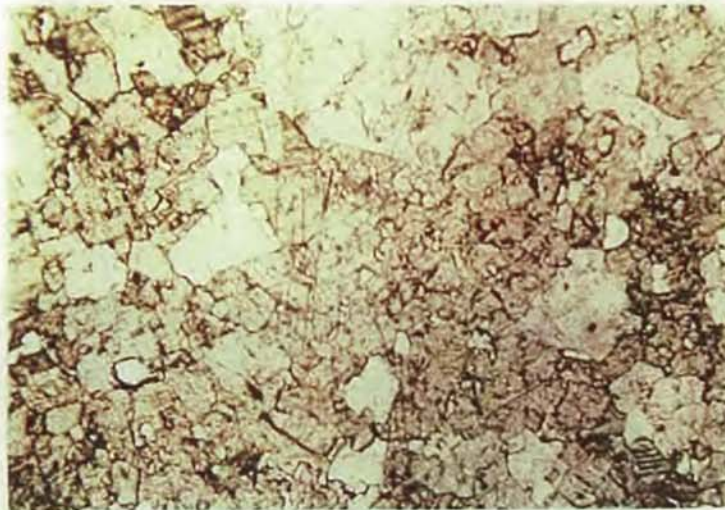


Fig. 18a Photomicrograph, x 24 mag., of thin section I21 under PPL. Magnesite with rare talc.



Fig. 18b Photomicrograph, x 24 mag., of thin section I21 under crossed nicols. Magnesite with rare talc.

Specimen I22

This specimen is dominantly composed of coarse subhedral to euhedral interlocking grains of magnesite associated with intergranular fibrous clusters of talc which often enclose smaller euhedral magnesite grains (Fig. 19).



Fig. 19 Photomicrograph, x 24 magnification, of thin section I22 under plane polarised light. Magnesite and interstitial aggregates of talc.

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Specimen I23: 'Black Gneiss 2' below talc vein'

Specimen I23 consists dominantly of medium grained anhedral interlocking quartz as orientated bands enclosing large microcline anhedral and anhedral aggregates. Scattered platy aggregates of muscovite occur orientated parallel to the general direction of the quartz banding. Minor epidote and chlorite also occur (Figs. 20a and 20b).

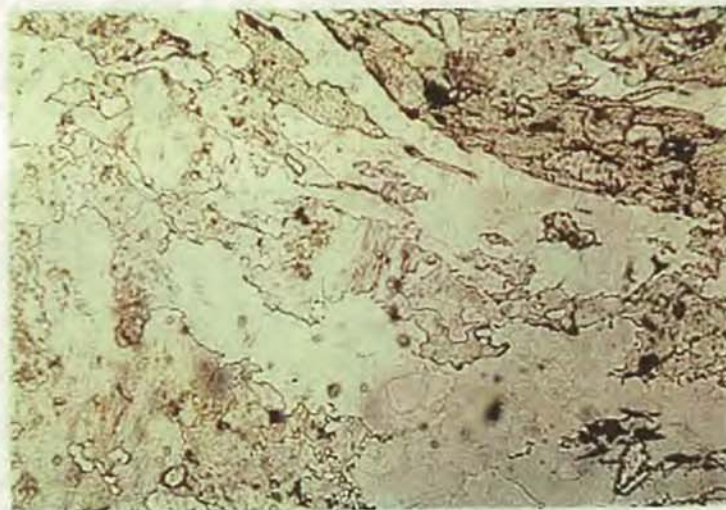


Fig. 20a Photomicrograph, x 24 mag., of thin section I23 under PPL. Quartz-muscovite-microcline gneiss.



Fig. 20b Photomicrograph, x 24 mag., of thin section I23 under XN. Quartz-muscovite-microcline gneiss.

Specimen I₂₄: 'Face 2, Talc next to carbonate'

This specimen of talc ore consists dominantly of coarse fibrous talc with minor chlorite (var. sheridanite) occurring as small lenticular fibrous aggregates within the main mass of talc (Figs. 21a and 21b). A few small subhedra of garnet are present. As in previous specimens there are two forms of talc present: (1) a talc that in thin section appears brown (Fig. 21a) under plane polarised light due to finely dispersed dusty inclusions of a transparent mineral and a brown amorphous material, (2) a clear transparent talc free of inclusions which appears to have been formed at the expense of the other by some metasomatic 'cleansing' process. Talc crystals in optical continuity can be seen to change sharply from 'dusty' brown talc to the clear talc.

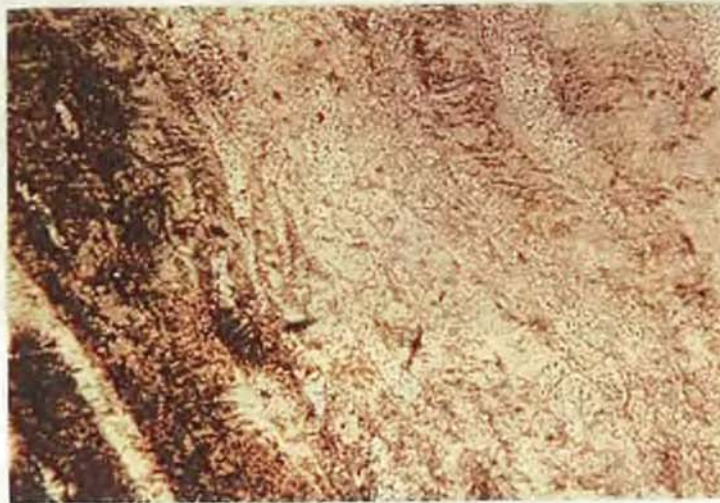


Fig. 21a Photomicrograph, x 24 mag., of thin section I₂₄ under PPL. 'Dusty' and clear talc enclosing small lenticular aggregates of chlorite.



Fig. 21b Photomicrograph, x24 mag., of thin section I₂₄ under XN. Coarse talc with lenticular aggregates of chlorite.

Specimen I25

This specimen of footwall rock consists of an interlocking aggregate of medium grained anhedral quartz enclosing occasional large anhedral of microcline feldspar (Figs. 22a, 22b). Minor magnesite occurs as pockets interstitial to the quartz, and also scattered laths of muscovite. Green chlorite (pennine) and epidote occur in trace amounts.

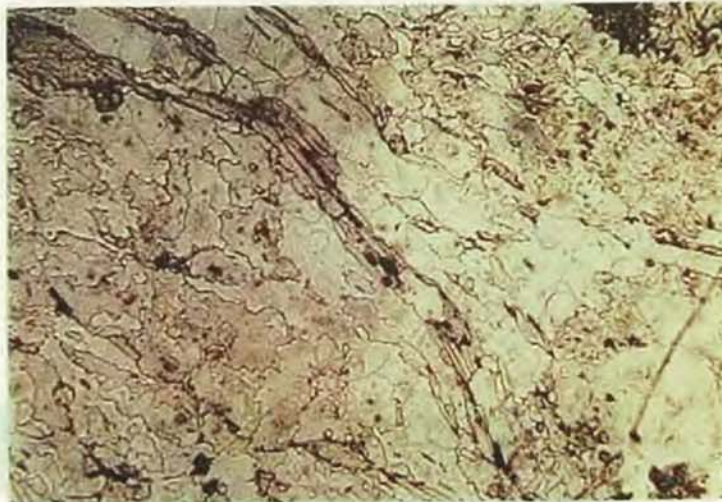


Fig. 22a Photomicrograph, x 24 mag., of thin section I25 under PPL; dominantly a quartz-microcline rock with minor muscovite and rare pennine and epidote.

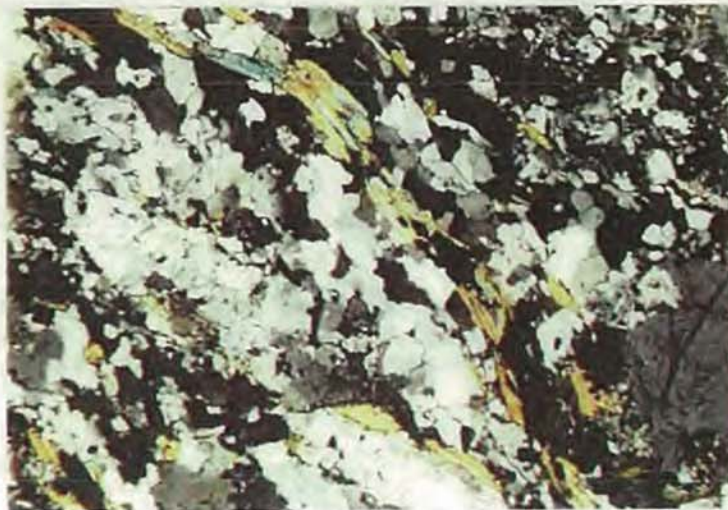


Fig. 22b Photomicrograph, x 24 mag., of thin section I25 under XN.

Specimen I26

This specimen contains chlorite, talc, magnesite and rutile. One part of the thin section consisted of a massive coarse fibrous and feathery aggregate of talc enclosing pockets of coarse magnesite. This texture graded into one which was dominantly fine grained chlorite (var. sheridanite) intimately intergrown with minor quantities of fibrous and platy talc (Fig. 23) as well as scattered small equigranular and rod-shaped rutile crystals.



Fig. 23. Photomicrograph, x 40 mag., of thin section I26 under crossed nicols showing minor talc (coloured) intimately intergrown with major chlorite.

Specimen I27

Specimen I27 is dominantly composed of quartz, chlorite (var. sheridanite) and talc (Figs. 24a and 24b). Thin lenticular bands of coarse feathery talc and chlorite alternate with anhedral granular interlocking aggregates of quartz. Scattered inclusions of rutile and epidote occur, as well as occasional large microcline anheda.



Fig. 24a Photomicrograph, x 40 mag., of thin section I27 under PPL, showing a fibrous and feathery aggregate of talc and chlorite enclosing anhedral segregations of quartz.

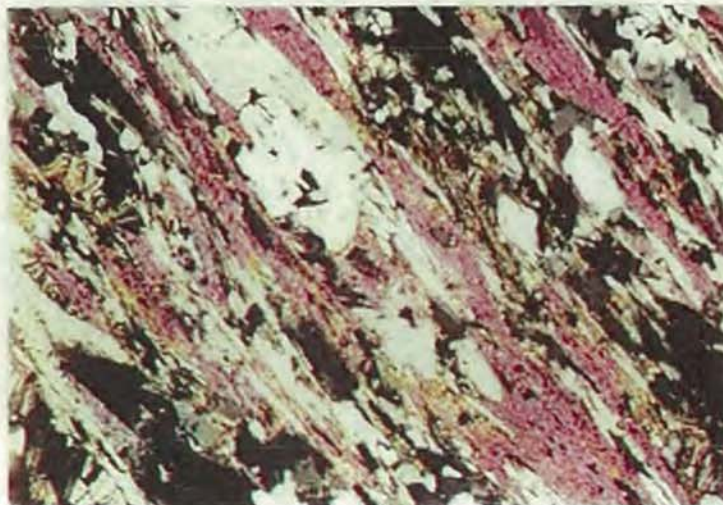


Fig. 24b Photomicrograph, x 40 mag., of thin section I27 under XN.

Specimen I29

Specimen I29 is a gneissic rock consisting of segregated bands of medium to fine interlocking anhedral quartz grains alternating with minor muscovite as orientated platy clusters, and enclosing large microcline anhedral. Some rare perthite and very rare epidote occur intergrown with the muscovite.

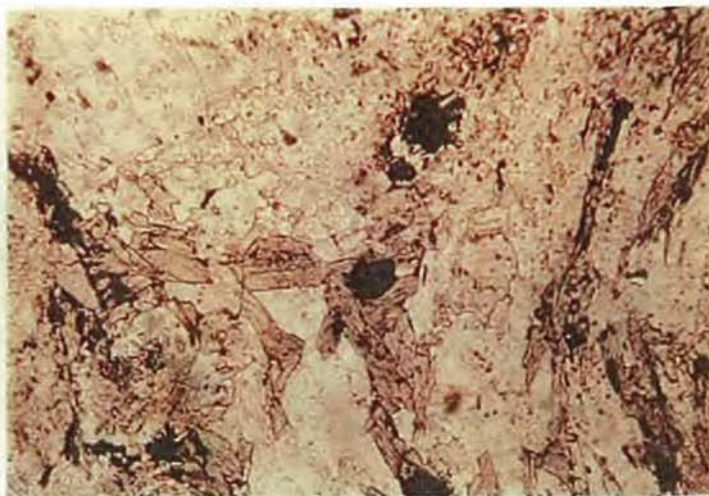


Fig. 25a Photomicrograph, x 24 mag., of thin section I29 under PPL; quartz, muscovite, and microcline (top left).



Fig. 25b. Photomicrograph, x 24 mag., of thin section I29 under XN.

Specimen I31

Specimen I31 is a muscovite-quartz schist containing minor pennine, sphene and tremolite.

The rock is dominantly made up of coarse orientated lamellar segregations of muscovite intergrown with flakes of minor greenish brown chlorite (pennine) and enclosing euhedral to subhedral grains of sphene. Minor interlocking fine to medium grained quartz segregations occur alternating with the muscovite bands. Hexagonal sections of an amphibole, probably tremolite, occur dispersed in the muscovite matrix.



Fig. 26a Photomicrograph, x 40 mag., of thin section I31 under PPL; muscovite-quartz schist.

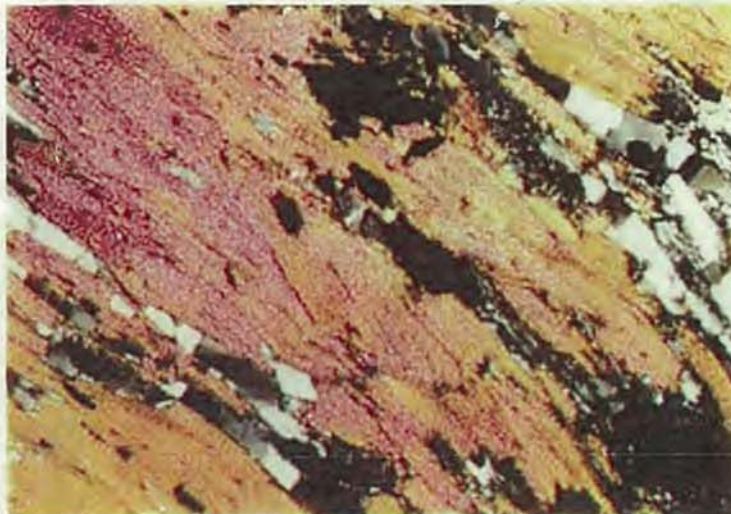


Fig. 26b Photomicrograph, x 40 mag., of thin section I31 under XN; muscovite-quartz schist.

Specimen I32

This specimen consists of coarse feathery lenticular aggregates of dominantly chlorite (var. sheridanite) intimately intergrown with minor amounts of talc (Figs. 27a and 27b).

Small inclusions of rutile occur along the boundaries (shear planes) between the chlorite aggregates and also along chlorite cleavage planes. Finely dispersed submicroscopic dusty inclusions of an unidentified phase similar to that found in talc occur in the chlorite.



Fig. 27a Photomicrograph, x 24 mag., of thin section I32 under XM. Feathery aggregates of sheared chlorite (white to greenish gray to black) with minor talc (coloured).



Fig. 27b Photomicrograph, x 24 mag., of thin section I32 under XM. Finer grained chlorite-talc mixture.

Specimen I33

This specimen of talc ore consists of a medium to fine grained randomly orientated intergrowth of dominantly talc with minor chlorite (var. sheridanite). The chlorite is intimately mixed with the talc (Fig. 28). Some pockets of coarse interlocking anhedral magnesite grains occur enclosed by the talc-chlorite matrix.

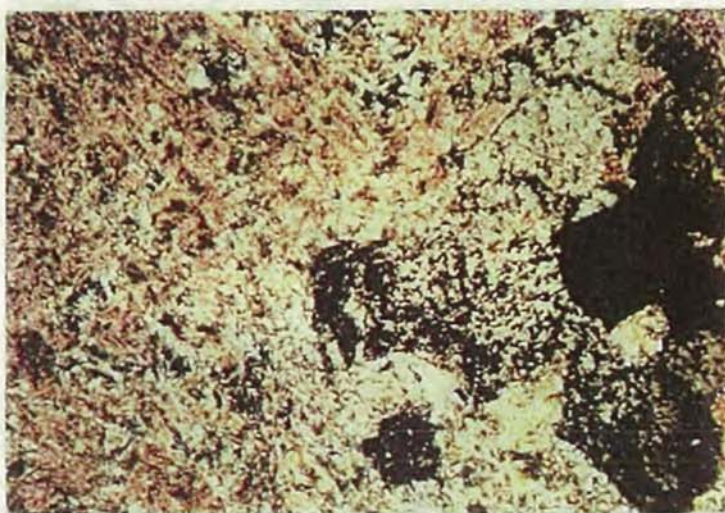


Fig. 28 Photomicrograph, x 24 mag., of thin section I33 under XN.

Specimen I35

This specimen consists dominantly of magnesite as a very coarse to medium grained interlocking aggregate of euhedral to subhedral grains. Minor tremolite occurs as long prismatic crystals forming interstitial clusters, and as solitary crystals penetrating the magnesite and along the grain boundaries of the magnesite. Minor chlorite (var. sheridanite) and rare talc occur associated with the tremolite segregations. (Figs. 29a, 29b).



Fig. 29a Photomicrograph, x 24 mag., of thin section I35 under PPL. Magnesite-tremolite-chlorite-talc rock.



Fig. 29b Photomicrograph, x 24 mag., of thin section I35 under XN. Prismatic tremolite in magnesite in the extinction position.

Specimen I37

This specimen consists dominantly of magnesite with minor talc. The magnesite occurs as an aggregate of very large magnesite anheda enclosed by finer grained subhedral magnesite which is intergrown with feathery intergranular clusters of talc (Fig. 30).

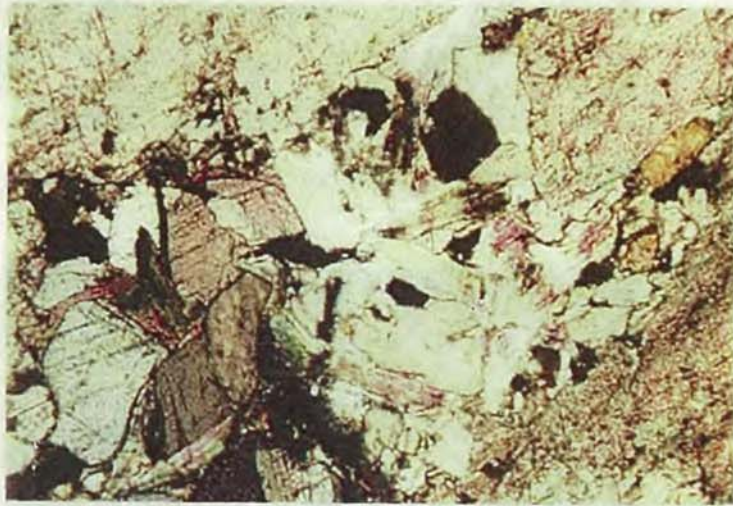


Fig. 30 Photomicrograph of thin section I37, x 24 mag., under XN showing the finer intergranular magnesite associated with small laths of talc (fibrous and coloured).

Specimen I39

This specimen is dominantly composed of talc forming coarse feathery aggregates intimately intergrown with minor finer grained chlorite (var. sheridanite) and containing fine disseminated inclusions of rutile. Occasional fine grained quartz as well as larger oval-shaped augen of quartz and rare garnet occur scattered throughout the talc matrix. The talc is for the most part crowded with inclusions, as in previous sections, but elongate areas of 'clean' talc occur as in Fig. 31a.

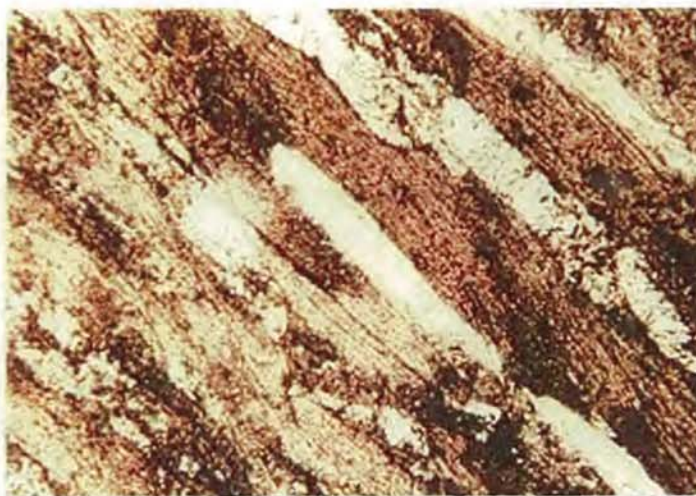


Fig. 31a Photomicrograph, x 24 mag., of thin section I39 under PPL.



Fig. 31b Photomicrograph, x 24 mag., of thin section I39, under XH

Specimen I41

This specimen of talc ore consists of a coarse aggregate of feathery talc intimately intergrown with minor chlorite (var. sheridanite), and enclosing rare large porphyroblasts of subhedral garnet which occasionally contain long prismatic inclusions of tremolite (Fig. 32a).



Fig. 32a Photomicrograph, x 24 mag., of thin section I41 under XN. Feathery aggregate of talc with garnet porphyroblast (bottom right, black).

Specimen I42: 'No.1 Face, green coloured'

Specimen I42 consists dominantly of an aggregate of fine grained fibrous chlorite (var. sheridanite) intimately intergrown with minor very fine grained talc as in Fig. 33.



Fig. 33 Photomicrograph, x 24 mag., of thin section I42 under crossed nicols of chlorite (white, greenish grey, black), and fine grained talc (yellow).

Specimen I43: 'Face 10 fibrous sample'

Specimen I43 consists dominantly of chlorite (var. sheridanite), occurring in the form of a coarse sheared fibrous aggregate intimately intergrown with very minor talc as in Figure 34.



Fig. 34 Photomicrograph, x 40 mag., of thin section I43 unde crossed nicols showing deformed fibrous chlorite (white-greenish grey-black) intergrown with platy and prismatic crystals of talc (coloured).

Specimen I43A

As for I43 the specimen consisted dominantly of chlorite (var. sheridanite) with very minor talc. The 'cross fibre' type texture found in I43 and produced by shearing at right angles to the schistosity was absent in specimen I43A.

Specimen I44: 'First face pure talc'

A coarse aggregate of lamellar talc showing a preferred orientation and enclosing augen of what appears to be an intimate intergrowth of quartz and serpentine (Fig. 35). Both talc crowded with fine unidentified inclusions and 'clear' talc are present. See also description for I45.



Fig. 35 Photomicrograph, x 24 mag., of section I44 under crossed nicols showing coarse lamellar talc enclosing rare anhedral segregations of probable serpentine-quartz composition.

Specimen I45: 'No.1 good specimen'

This specimen of 'talc ore' consists nearly wholly of talc occurring in the form of a randomly orientated 'matted' aggregate of fibrous talc enclosing minor quartz-serpentine augen. As in previous sections the talc is rendered murky or dusty by fine inclusions of a brown amorphous material and an unidentified transparent phase. In places the talc has been cleansed of these inclusions along zones which appear to be independent of any intergrowth or crystallographic features of the talc (Fig. 36).

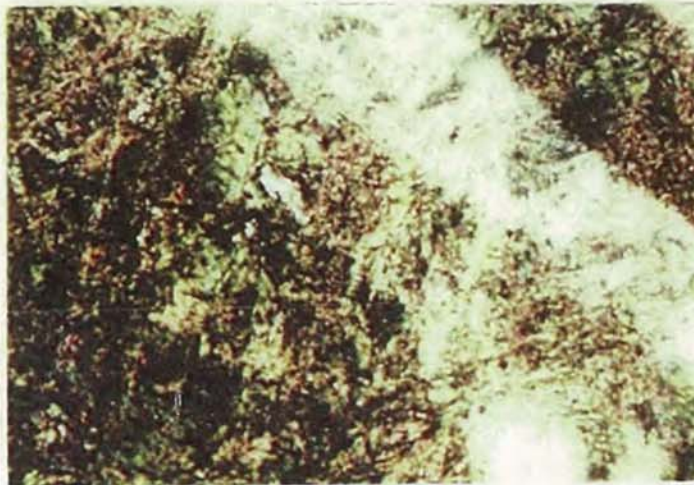
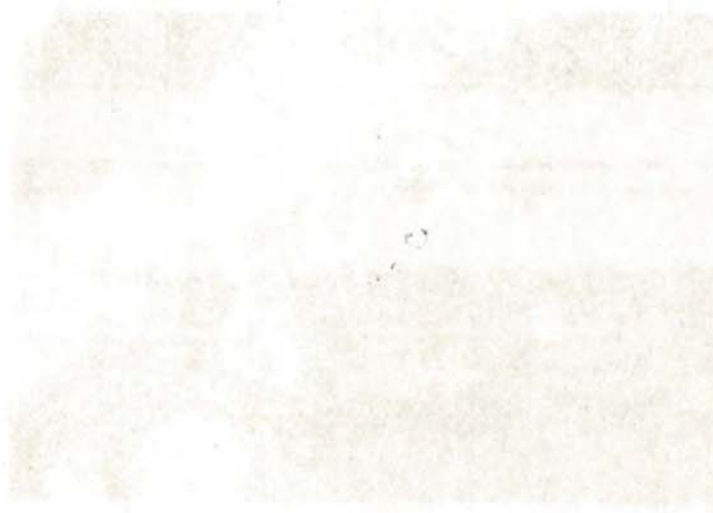


Fig. 36 Photomicrograph, x 24 mag., of thin specimen I45 under crossed nicols showing the form of aggregation of the talc and the difference between the 'murky' talc and the linear transgressive zone of 'clear' talc.

Specimen I46: 'No.3 face, coloured'

This specimen consists of very coarse lenticular aggregates of long fibrous and feathery talc crystals enclosing rare anhedral porphyroblasts of garnet.



DIGESTIVE TESTS

To confirm the presence of acid soluble carbonate material and also to help identify the type of carbonate present in the rock specimens collected, each powder specimen was subjected to a digestive test.

Half gram quantities of each of the powders were treated with normal hydrochloric acid for several hours at approximately 70°C. The residues were reweighed and the filtrates were analysed for their calcium and magnesium content using the EEL, 240 Atomic Absorption Spectrophotometer. The aim of the digestion was not to estimate the total acid soluble fraction only to help establish the carbonate minerals present and to estimate roughly their quantity to help interpret the X-ray powder photographs obtained from the samples.

The results are present under three headings, namely 'Rock Types', 'Carbonate Specimens', and 'Talc Specimens'.

It can be seen that only small quantities of carbonate material are present in the talc specimen group, similarly in the rock specimens with the exception of the marble specimen which is practically 100% calcite. The carbonate group of specimens appear to be mixtures of calcium and magnesium carbonate with a number of specimens being possible dolomites.

ROCK TYPES

Specimen No.	% Weight Loss	% Calcium	% Magnesium
I1	<0.2%	<0.2%	<0.2%
I7	3.0%	<0.2%	<0.2%
I12	<0.2%	<0.2%	<0.2%
I13	4.2%	1.0%	0.4%
I15	6.0%	<0.2%	0.4%
I16	4.8%	2.0%	0.4%
I17	6.0%	<0.2%	<0.2%
I20	11.2%	<0.2%	<0.2%
I23	1.4%	<0.2%	<0.2%
I25	22.4%	<0.2%	<0.2%
I27	9.0%	<0.2%	<0.2%
I29	3.6%	<0.2%	<0.2%
I31	9.6%	<0.2%	<0.2%
I34	92.2%	>20.0%	<0.2%

CARBONATE SPECIMENS

Specimen No.	% Weight Loss	% Calcium	% Magnesium
I4	22.8%	3.0%	1.1%
I6	48.0%	6.0%	1.15%
I11	21.6%	3.0%	6.4%
I14	44.2%	7.0%	5.0%
I18	75.2%	14.0%	24.0%
I19	37.8%	5.0%	4.0%
I21	61.8%	8.4%	8.0%
I22	91.2%	16.0%	15.2%
I30	15.0%	1.9%	1.6%
I35	50.8%	6.6%	13.4%
I37	51.0%	4.4%	24.0%

TALC SPECIMENS

Specimen No.	% Weight Loss	% Calcium	% Magnesium
I2	3.6%	<0.2%	0.4%
I3	1.6%	<0.2%	<0.2%
I5	5.4%	<0.2%	<0.2%
I8	6.0%	<0.2%	<0.2%
I9	<0.2%	<0.2%	<0.2%
I10	4.2%	<0.2%	<0.2%
I24	8.0%	<0.2%	<0.2%
I26	<0.2%	<0.2%	<0.2%
I28	12.6%	<0.2%	<0.2%
I32	1.2%	<0.2%	0.4%
I33	5.6%	0.34%	<0.2%
I36	4.6%	<0.2%	<0.2%

/Continued....

TALC SPECIMENS (Continued)

Specimen No.	% Weight Loss	% Calcium	% Magnesium
I38	1.0%	<0.2%	<0.2%
I39	<0.2%	<0.2%	<0.2%
I40	7.0%	<0.2%	<0.2%
I41	<0.2%	<0.2%	<0.2%
I42	0.8%	<0.2%	<0.2%
I43	6.2%	<0.2%	<0.2%
I44	<0.2%	<0.2%	<0.2%
I45	8.0%	<0.2%	<0.2%

Electron Microscope Examination of Italian
Mine Samples and Imported Batch Shipments of
Italian Powder

The main purpose of the electron microscope examination of mine samples and also representative fractions of the Italian powder has been to establish whether or not any particles corresponding to the commercial forms of asbestos were present. The electron microscope is an instrument which is most usefully employed in the examination of particles less than ten microns in size. It has been used in this investigation therefore to examine only the finer particulate portion of the Italian samples. It may be argued that only a small fraction of each of the powdered samples was examined and that this was not representative of the total sample. However, we can assume that the fraction examined was representative of the dust formed from each sample and that it is this finer fraction which is the most important from a biological standpoint. Also as the size of the biologically active commercial asbestos particles fall entirely within the particle size range examined we can consider the main aim of the examination to be entirely satisfied by only looking at the finer fractions from each of the Italian samples.

To acquaint ourselves with the type of particles formed by the commercial asbestos minerals, Figs. have been included. They represent samples of Amosite, Crocidolite, Anthophyllite and Chrysotile asbestos. Also Figs. have been inserted to demonstrate typical single particle electron diffraction patterns which can be obtained from the four asbestos types for comparison with patterns obtained from the Italian samples.

Sample Preparation

Small portions of the powdered rock samples and imported powder specimens were placed in 15cc centrifuge tubes to which distilled water was added. The powders were then dispersed first by hand shaking and then with the aid of a small ultrasonic bath. The concentration of suspended material in the tubes was adjusted by eye using dilutions of distilled water. The tubes containing suspended solids were then allowed to stand for 20 minutes to allow the larger particles of mineral to sediment to the bottom of the tubes.

Electron microscope grids coated with carbon films were prepared and small drops of the particulate material from each of the specimen tubes were mounted on specimen grids and allowed to dry. The specimens were inserted into an A.E.I. E.M.6. electron microscope and examined for particles resembling commercial asbestos fibres. Where suitable particles were observed, selected area electron diffraction patterns were produced by the commercial asbestos minerals. In all cases photomicrographs representative of the type of particles found in each sample were taken while interesting diffraction patterns were also recorded.

Particle Morphology

The carbonate rich materials were found to produce compact particles which were very electron dense. On the whole they were finer particles than those obtained after crushing talc rich specimens. No fibrous material whatsoever was found when carbonate material only was comminuted. The morphology of particles produced from the footwall rocks i.e. limestone, marble, gneiss and the amphibolites were also very compact, although in the gneiss specimen platy particles were present probably representing the muscovite content of the specimen. Again in the footwall rock specimens fibrous particles were very scarce. Those lath like particles detected resembled the amphibole minerals rather than chrysotile. Selected area diffraction patterns which were obtained from the lath like particles in no way resembled the typical amphibole fibre diffraction pattern. They were generally very distorted patterns containing streaks rather than spots indicating a rather stressed and deformed material.

The specimens which were composed of talc together with other mineral associations, presented a very different picture, as far as particle shape was concerned. In the main particles were flat and plate-like, some being very thin and translucent in the electron beam. Particle sizes varied from very small to quite large plates some with very sharp discrete edges, others with rather ragged outlines. Comparing particles from those samples of talc which varied in bulk morphology in hand specimens, no observable difference could be drawn between them. Similarly, a comparison of particles produced from talc specimens of varying colour revealed no differences in the overall particle shape. The same thing applied to those specimens with talc rich specimens, again no distinct differences in the type of particles formed during comminution of the bulk specimens were observed.

There were, however, observable differences in particle morphology between individual powder specimens. In the main most produced good plate like particles, however, one or two specimens were found to contain considerable numbers of lath like particles, these being very thin in character. These particles resembled the amphibole asbestos type particle being less regular and also very much larger in projected diameter. Diffraction patterns from these particles matched those obtained from the platy particles with which they were associated and in no way resembled the typical amphibole diffraction pattern obtained from single amphibole asbestos fibres.

Other fibrous particles were observed in the mainly talc specimens which to some extent resembled chrysotile asbestos fibres rather than amphibole minerals. They often had a somewhat textile appearance but were, however, crystalline. Diffraction patterns from these fibres were very distorted and in no way matched typical chrysotile or amphibole patterns.

The only group of specimens in which amphibole fibres were confirmed were in those specimens with known amphibole composition. However, even the fibres found in these specimens barely resembled the fibres formed by the commercial amphibole asbestos minerals. To assess the particles produced from the pure amphibole mineral (Tremolite), found in three of the specimens, small crystals of the mineral were taken from the hand specimens and crushed separately. An examination of the finer particles produced revealed stubby electron dense fibres associated with irregular lumps of the same mineral. Diffraction patterns from these fibres were similar to those obtained from the commercial amphibole minerals, although they were more difficult to obtain because of the greater thickness of these particles. Other specimens in the group, which did not contain talc but were composed of sheet silicate minerals mainly muscovite, were also practically free of fibrous particles. There appeared to be no general tendency for these other minerals to form fine fibrous particles. A number of very fine short fibres were observed on grids prepared from several of the talc specimens, these were, however, chance small pieces torn from the edges of talc plates. They appeared in those samples which had a tendency to form copious numbers of very fine particles when subjected to comminution.

The specimens examined can be grouped into four categories on the basis of particle morphology and they are as follows:

- (a) Talc specimens with impurities of carbonate and chlorite.
- (b) Rock type specimens, i.e. footwall limestone etc.
- (c) Those specimens composed mainly of carbonates.
- (d) Amphibole specimens with carbonate and talc.

The talc specimens were characterized by the large number of plate like particles often translucent in the electron beam. Rock specimens varied from specimens which were composed mainly of compact electron dense particles to those with some sheet silicate content in which plate like particles become apparent. Those specimens composed mainly of carbonate material produced compact rounded particles, often very small and grouped together in aggregates. Finally the specimens containing amphibole were characterized by the compact nature of the particles with evenly distributed fibres and very few translucent plates. The groups of particles described are illustrated by the following micrographs which illustrate the various forms.

Selected area electron diffraction patterns obtained from single particles of the amphibole mineral are also presented showing the similarity of these patterns to those obtained from commercial asbestos fibres. Also included are single crystals patterns and polycrystalline patterns, from talc, chlorite and muscovite rich specimens. It can be seen that they are very different in character to those obtained from the amphibole mineral. However, patterns from the sheet silicate minerals mentioned above are all very similar and it is impossible to identify each of these minerals from their

electron diffraction patterns or to tell them apart without applying a more sophisticated approach to the diffraction procedure. With specimen tilt facilities enabling the particle to be rotated through more than 45° discrimination is possible between certain of these minerals.

As mentioned earlier, patterns obtained from lath like particles found in the talc specimens were identical to those observed from general plate like forms. Those fibres with a textile like appearance often only gave very streaked patterns but in one or two cases these also resembled very closely the normal talc pattern.

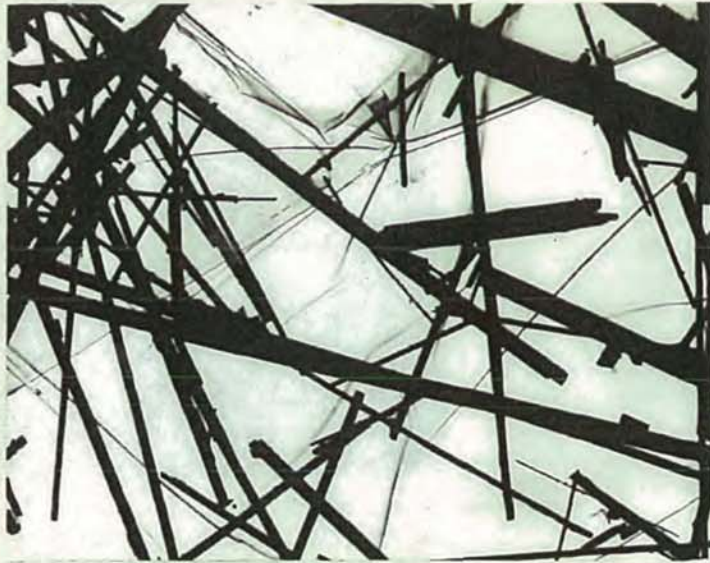
Examples of Commercial Amphibole and Chrysotile asbestos particles together with typical selected area electron diffraction patterns.



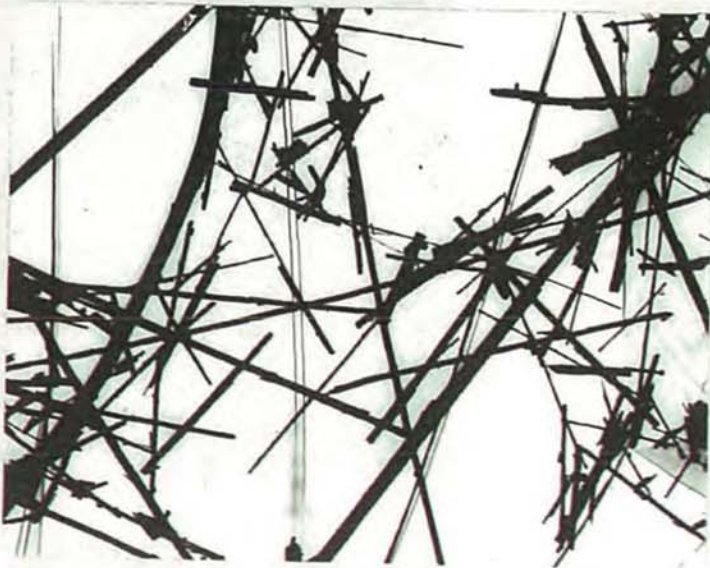
Chrysotile asbestos particles x 3000



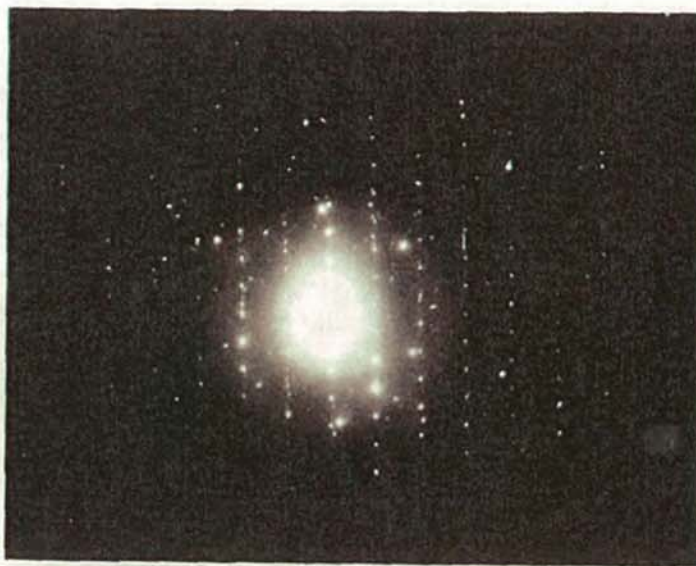
Anthophyllite asbestos particles x 3000



Amosite asbestos particles x 3000



Crocidolite asbestos particles x 3000



Amphibole asbestos selected area
electron diffraction pattern.



Chrysotile asbestos selected area
electron diffraction pattern.

Electron micrographs of particles produced from
specimens which have been classified as rock
types.

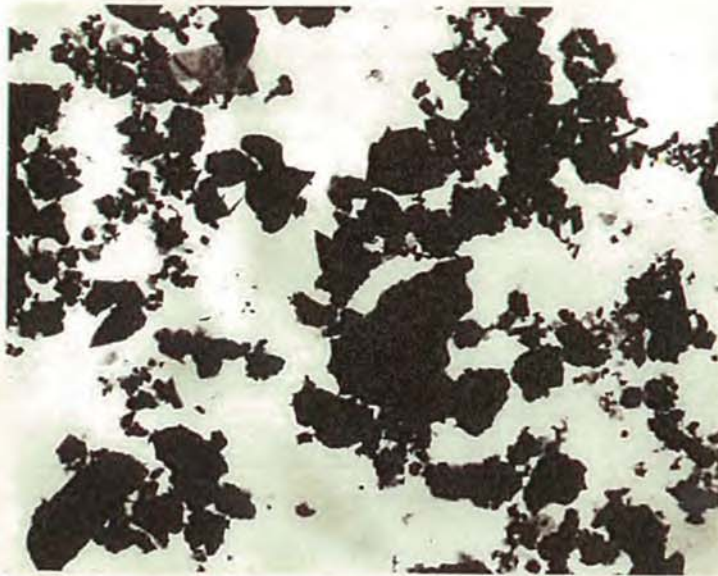


Fig. 1. Specimen I13 seam inclusion showing passage into talc x 3000. The particles are mainly compact and electron dense. A few flakes, no fibres present.

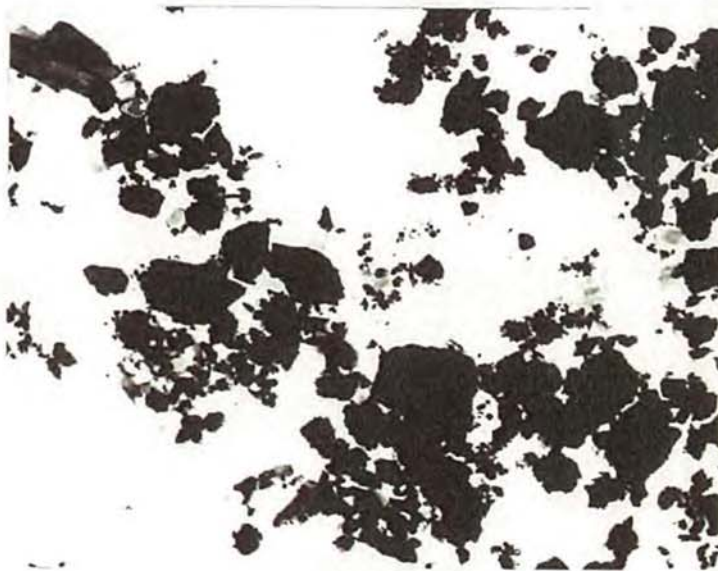


Fig. 2. Specimen I15. Talc footwall contact. x 3000. Compact particles with a few small flakes. No fibres present.

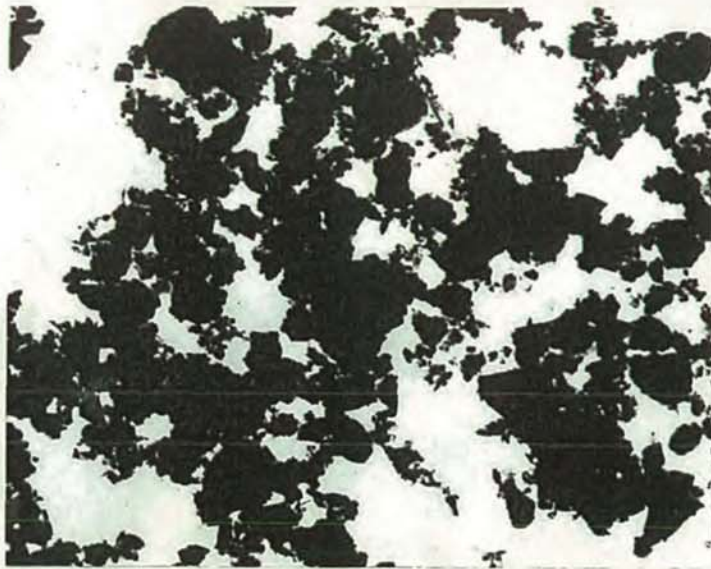


Fig. 3. Specimen I16. Lithological inclusion from Face 1. x 3000. Compact electron dense particles. No fibres present.



Fig. 4. Specimen I17. Footwall rock sample, x 3000. Mainly compact particles produced with a few plate like forms.



Fig. 5. Specimen I23. Black gneiss, 2ft below talc seam. x 3000. Compact electron dense particles produced.

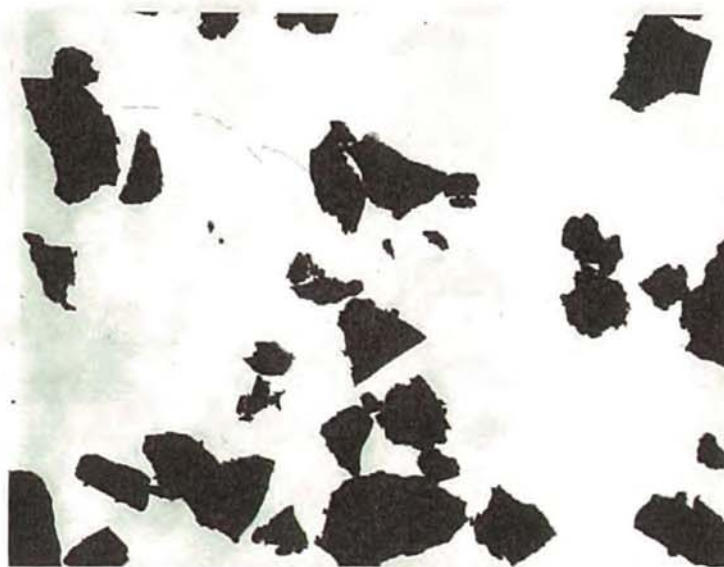


Fig. 6. Specimen I25. Footwall limestone. x 3000. Compact electron dense particles.

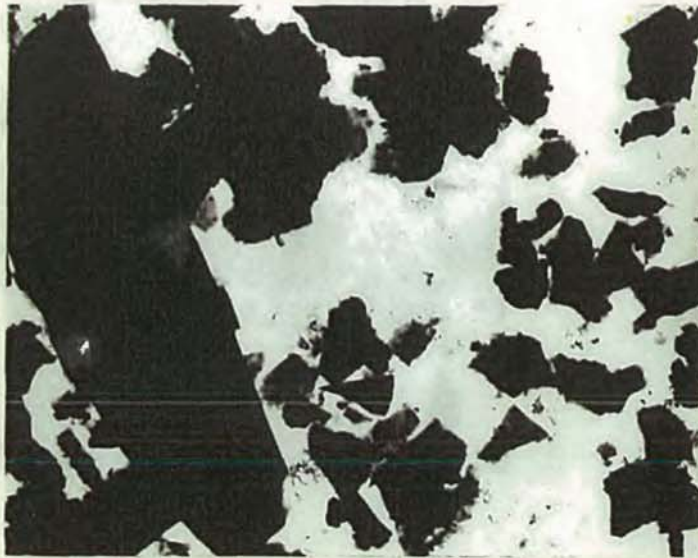


Fig. 7. Specimen I27. Lithological inclusion face 1.
x 3000. Platey electron dense particles.
No fibres.



Fig. 8. Specimen I29. Sample 6 Footwall. x 3000
Compact electron dense particles with a few
plate-like forms.

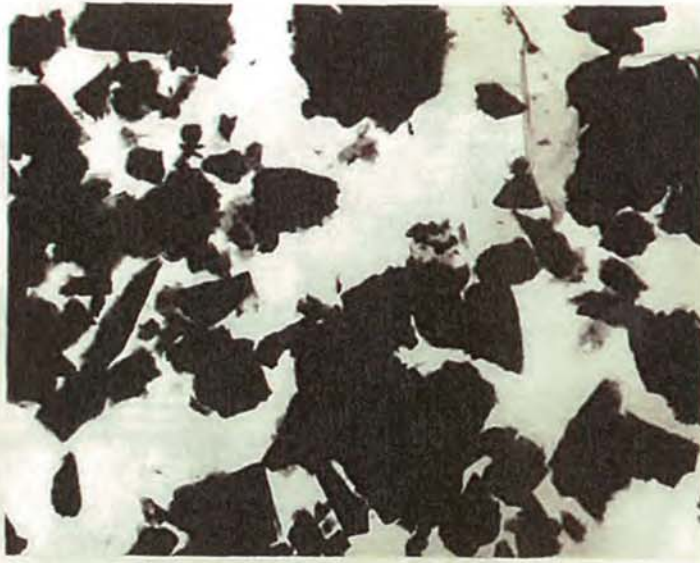


Fig. 9. Specimen I31. Black inclusion face 1. x 3000
A mixture of plate-like and compact forms
mainly electron dense in character.

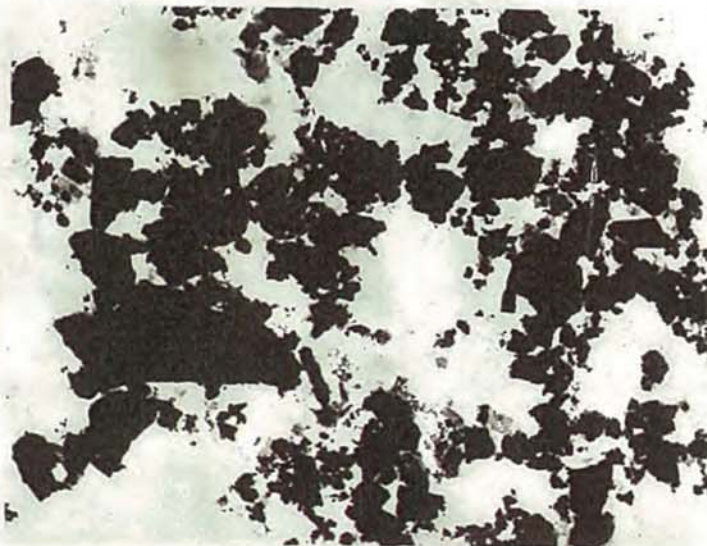
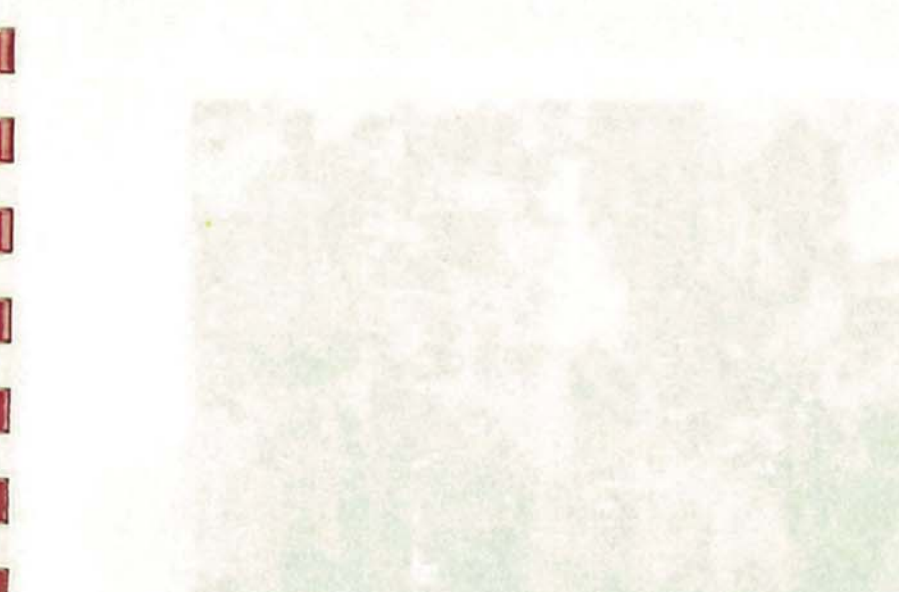

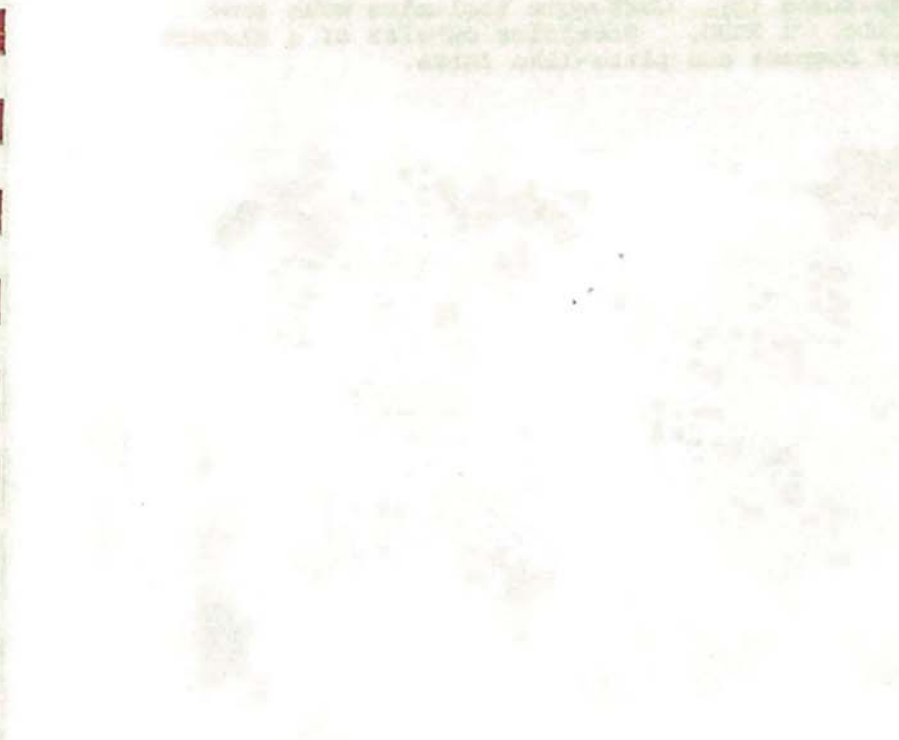


Fig.10. Specimen I34. Marble from tunnel wall. x 3000
Mainly compact electron dense particles with a
few plate-like forms.



Electron micrographs of particles produced from those
specimens mainly composed of carbonate minerals.



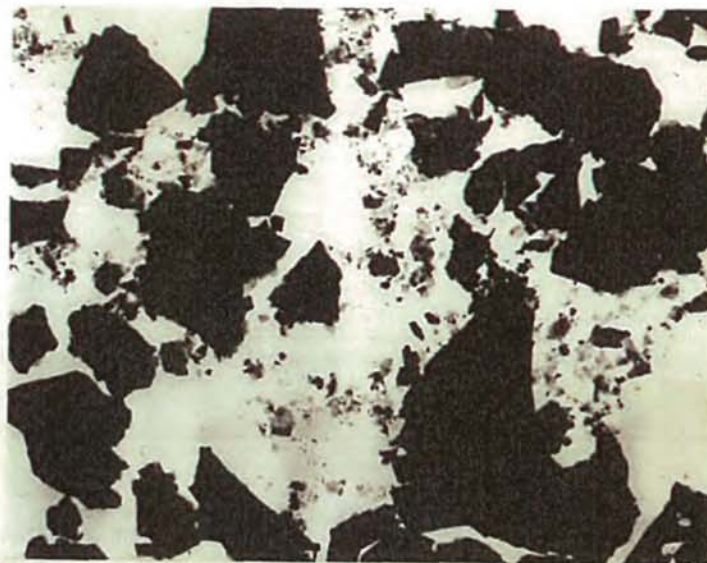


Fig. 1. Specimen I₁₁. Carbonate inclusion with some talc. x 3000. Particles consist of a mixture of compact and plate-like forms.



Fig. 2. Specimen I₁₄. Inclusion in talc seam Face 4, middle of seam. x 3000. Granular particles with plate-like types and lath-like forms.



Fig. 3. Specimen I18. Carbonate/talc sample, x 3000. Particles compact and electron dense. A few plate-like forms.



Fig. 4. Specimen I21. Inclusion from Face 2. x 3000. This specimen produced plate-like and compact particles with some lath-like forms.



Fig. 5. Specimen I35. Massive carbonate from rear end of working, x 3000. Compact electron dense particles with some plate-like talc particles.

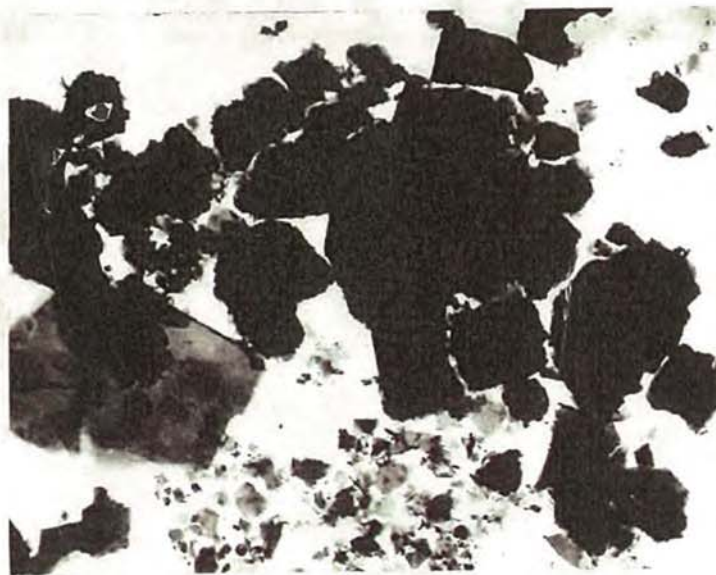
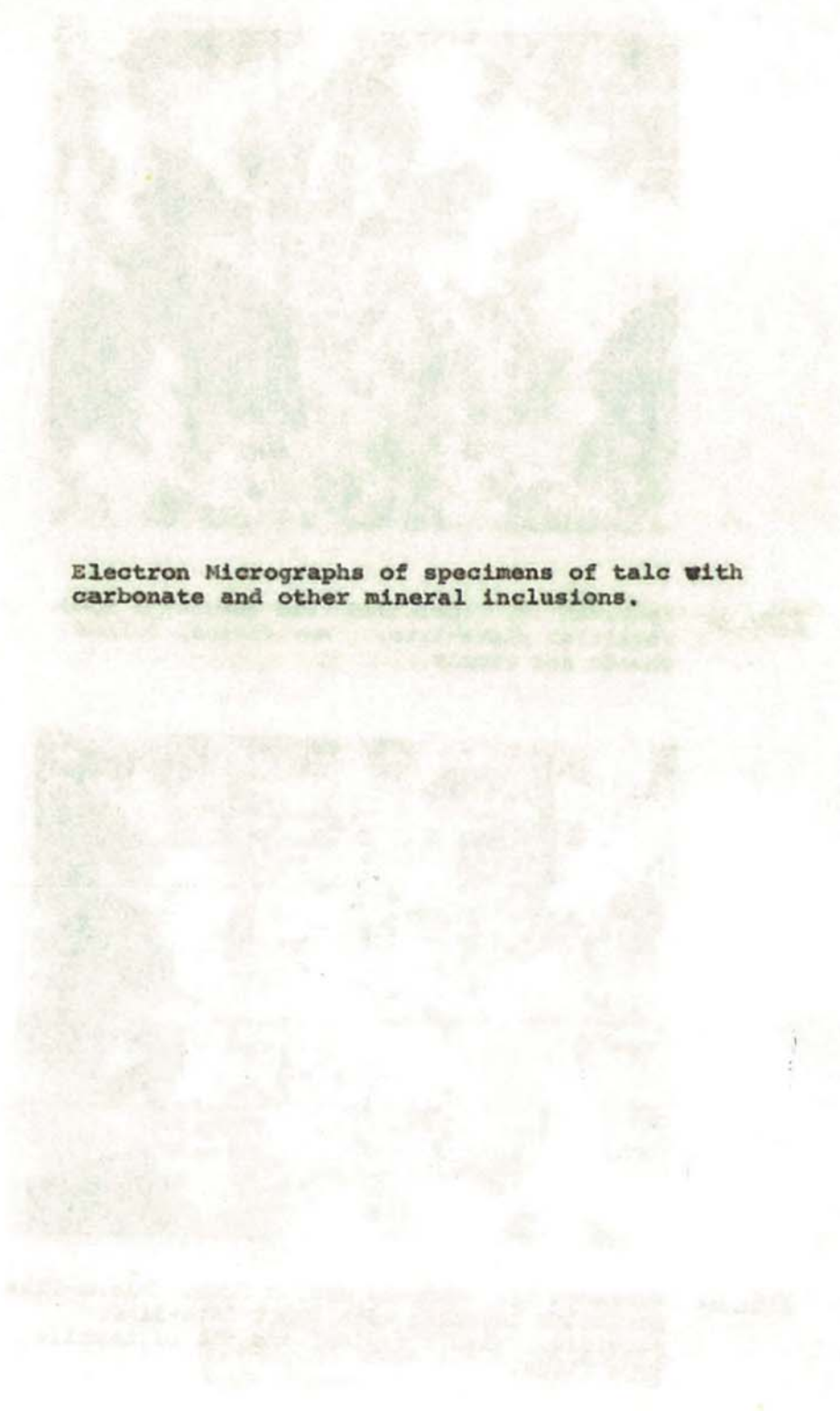


Fig. 6. Specimen I37. Carbonate in talc inclusion x 3000. Compact particles together with some plate-like forms and rolled talc sheets.



Electron Micrographs of specimens of talc with
carbonate and other mineral inclusions.



Fig. 1. Specimen I3. Coloured talc (Green) x 3000. Particles plate-like. Few fibres, rolled sheets and shords.



Fig. 2. Specimen I5. General ore, x 3000. Plate-like particles together with short lath-like particles, also a typical example of textile type fibre.



Fig. 3. Specimen 1g. Massive talc, x 3000. Plate-like particles with a few lath-forms also typical textile type long fibre.

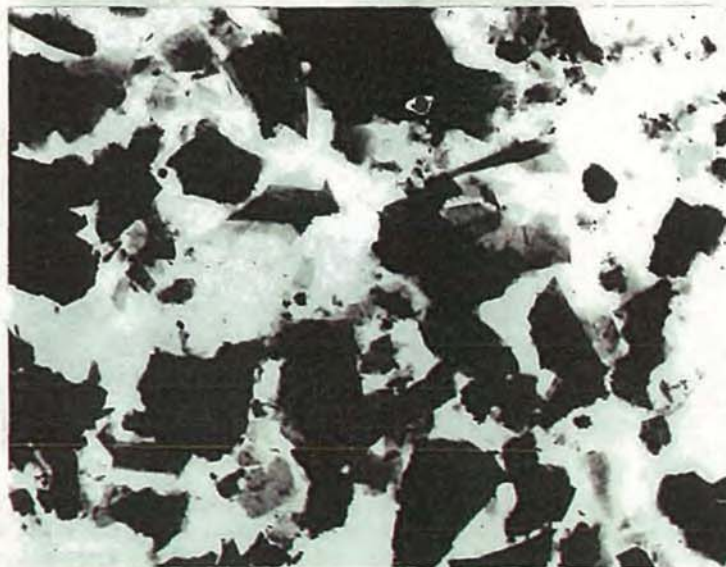


Fig. 4. Specimen 1g. Grey talc First Face, x 3000. Practically all plate-like with a few lath forms.



Fig. 5. Specimen I10. Granular talc, x 3000.
All plate-like particles.



Fig. 6. Specimen I24. Talc next to carbonate inclusion,
x 3000. This specimen was found to contain a
large number of lath-like particles, as can be
seen from the micrograph above. No diffraction
pattern corresponding with an amphibole fibre
was obtained from a selection of the elongated
particles.



Fig. 7. Specimen I26. Coloured talc inclusions, x 3000. The particles produced from the various coloured inclusions in the talc were found to be mainly plate-like with a few lath forms.



Fig. 8. Specimen I28. Talc/Quartz specimen, x 3000. Particles from this specimen were mainly plate-like but accompanied by more compact opaque particles. A few textile type fibres were observed.



Fig. 9. Specimen I32. Face 2 inclusion from base of talc seam, x 3000. The specimen produced a mixture of irregular particles varying from compact to plate-like in form with a few lath like particles.

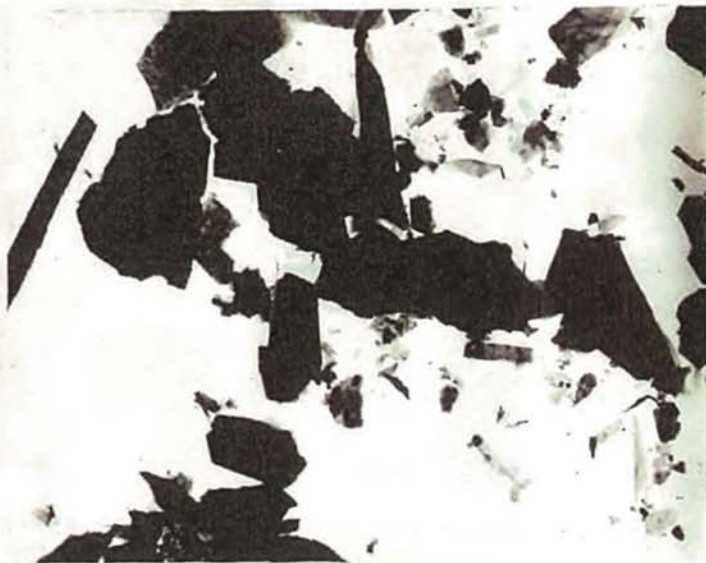


Fig.10. Specimen I33. Talc from lower left end of working x 3000. Particles mainly plate-like with some lath forms.

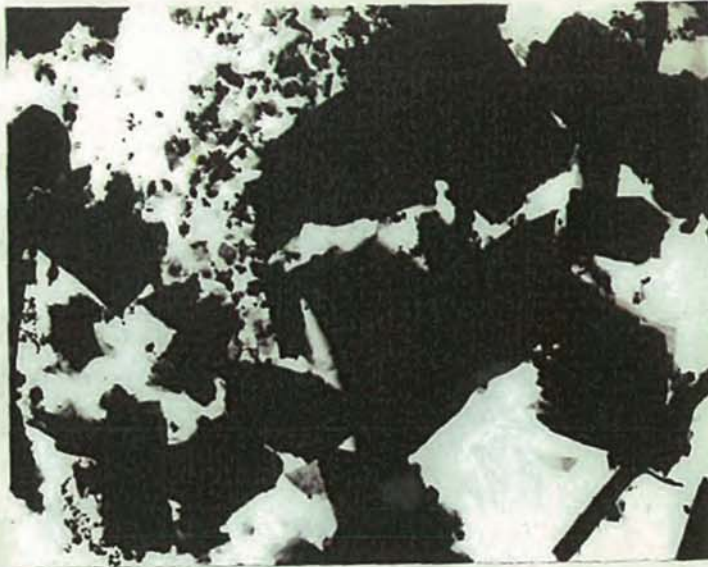


Fig. 11. Specimen I38. Pyrite/Talc specimen, x 3000. Plate-like particles with some rolled tubes of talc.

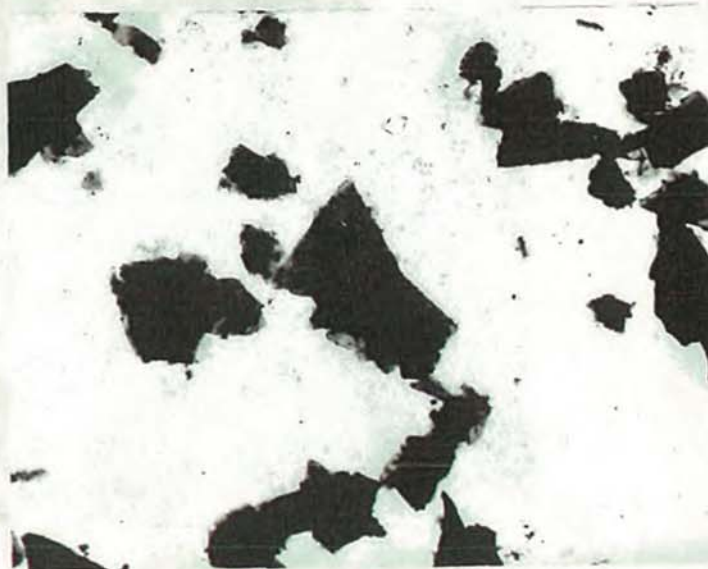


Fig. 12. Specimen I39. 5+ - 0 coloured pieces from the crusher, x 3000. These various coloured talc pieces produced only plate-like particles.



Fig. 13 Specimen I41. Page 2, good talc specimen x 3000. Plate-like particles together with rolled talc sheets lath forms and textile type fibres.

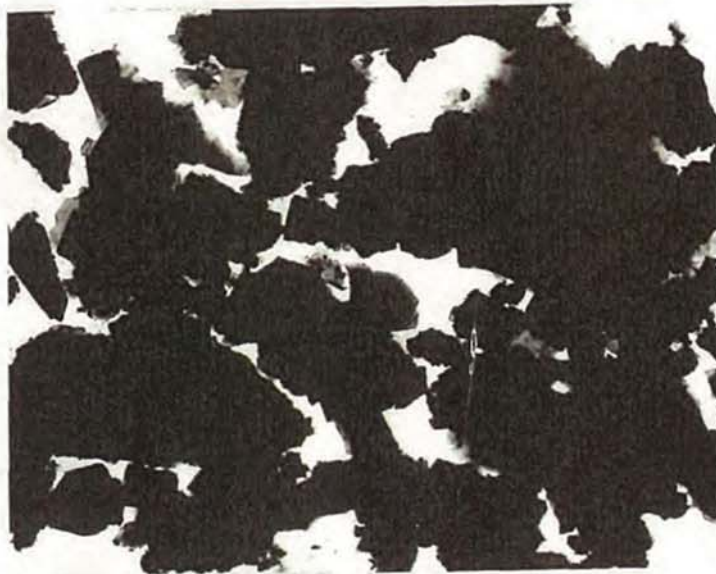


Fig. 14. Specimen I42. Page 1, green coloured talc, x 3000. This coloured specimen produced plate-like particles which were rather more electron dense.



Fig. 15. Specimen I43. Face 10. Fibrous looking hand specimen, x 3000. This sample was found to be practically all plate-like in form.

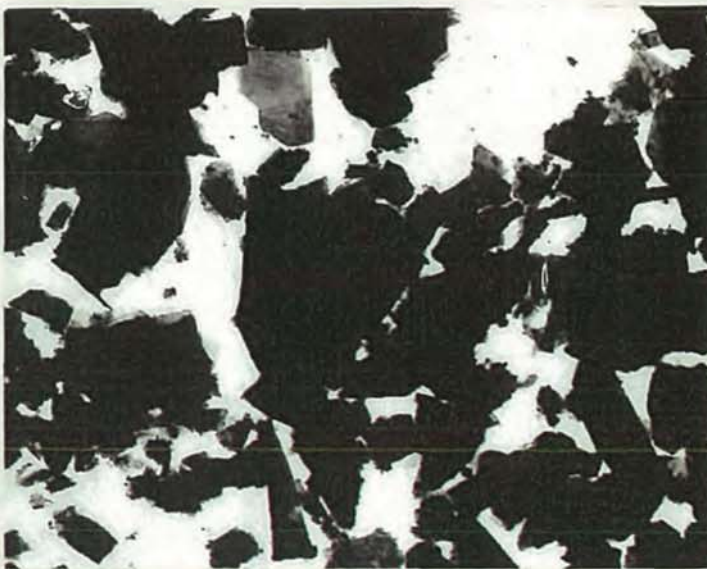


Fig. 16. Specimen I44. Face 1. Pure talc sample, x3000. Plate-like particles with some lath-like forms.



Fig. 17. Specimen 145. Face 1. Good talc specimen,
x 3000. A mixture of plate-like particles and
fibrous forms, including rolled tubes and
textile type fibres.

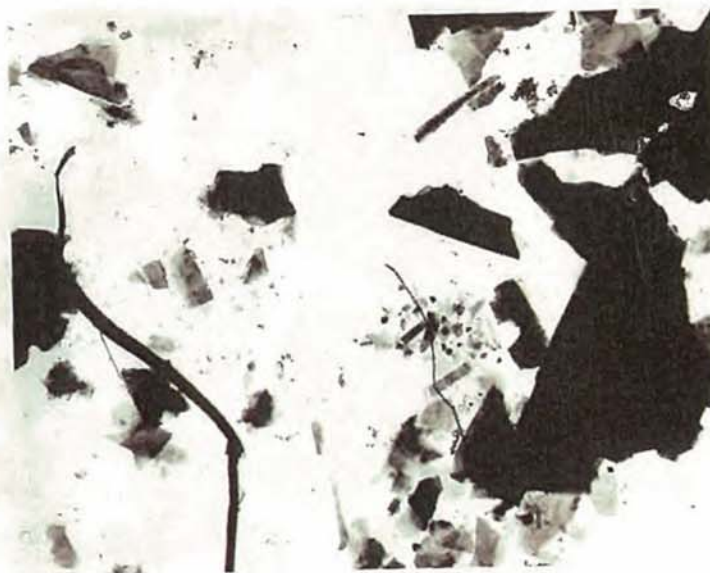
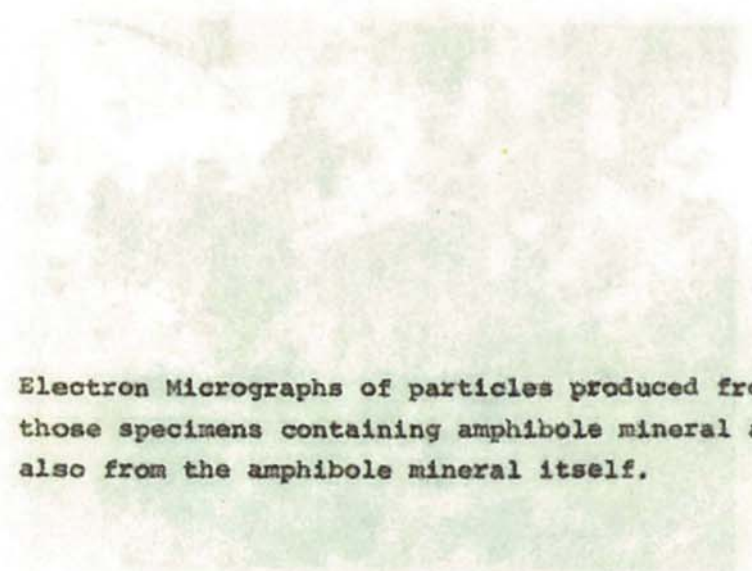


Fig. 18. Specimen 146. Face 3. Coloured specimen
x 3000. Plate-like particles with shards and
lath like forms, together with a typical
textile form, which can be seen to have a
sheet-like form.



Electron Micrographs of particles produced from
those specimens containing amphibole mineral and
also from the amphibole mineral itself.


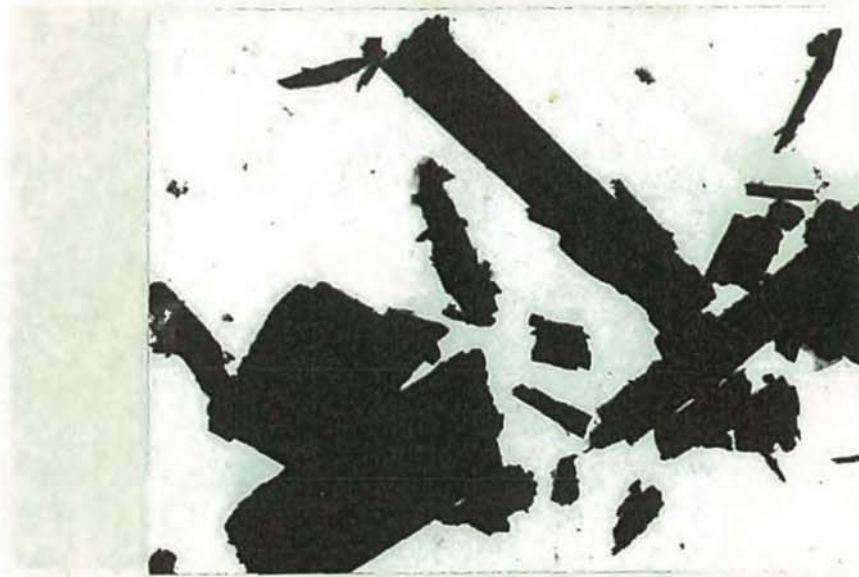




Fig. 1. Specimen I19. Tremolite/carbonate talc sample x 3000. Compact particles, a few lath forms present.



Fig. 2. Specimen I20. Amphibole sample from Guiana level 1212. x 3000. Compact particles with numerous lath forms.



Figs. 3 and 4

Particles produced from single crystals of tremolite extracted from specimens I19 and I20. x 3000. Very few fibrous particles were produced when this specimen was crushed. Those that were fibrous in nature were thick and stubby in character, less than 50% of the particles were elongated in shape.



Figs. 5 and 6

Selected area electron diffraction patterns
obtained from amphibole particles found in
specimens I19 and I20.



Fig. 7. Typical selected area diffraction pattern obtained from talc plates.

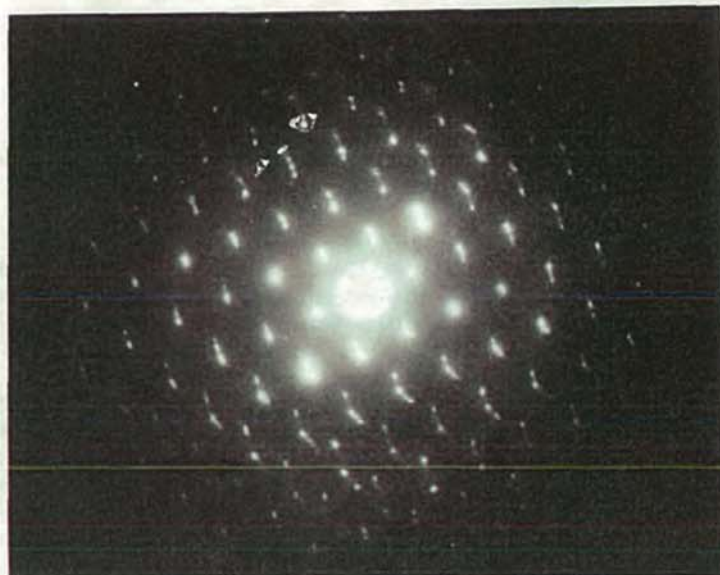


Fig. 8. Selected area diffraction pattern obtained from a typical textile type fibre showing features of a rotated or coiled structure.

X-RAY ANALYSIS OF ITALIAN MINE SAMPLES

Introduction

This report concerns the X-ray powder analysis of the Italian mine samples. The samples were classified into three categories according to their chemical and physical properties:

- (i) 'Rock' Type
- (ii) 'Talc' Type
- (iii) 'Carbonate' Type

All the samples were prepared by similar means and the procedure for obtaining the X-ray powder patterns was standardised.

From these powder photographs, several were chosen which clearly showed distinct mineral phases. These were used as standards for this group of samples. These standard patterns were compared against the ASTM index and this comparison illustrates the need to prepare standards for a particular locality from specimens at that locality.

The samples were compared with these standards by computer methods and visually and the results and discrepancies between the methods of comparison noted.

LIST OF SAMPLES

See Table 1

SAMPLE PREPARATION

The samples were received mainly as large rocks and were labelled according to their appearance and location in the mine.

With the larger samples a section was cut from the middle to be a representative sample, for the smaller samples as many pieces as possible were crushed to form the representative sample.

These samples were then roughly broken up and placed in a 'Tema' disc mill and ground for 5 mins. until all the sample was below approx. 100 mesh. These powders were stored in clean plastic bags. The samples, when required for X-ray analysis, were further ground (to less than 3000 mesh) in a small agate ball mill and then sieved through a 350 mesh screen and stored in plastic bags.

The grinding mills and other apparatus used were thoroughly cleaned between samples and during the grinding care was taken to obtain a good representative sample.

X-RAY ANALYSIS

All the samples were analysed using a Debye-Scherrer camera mounted on a Raymax RX 3-D X-ray generator. A copper X-ray tube was used with nickel filters (0.02 mm thick) and the power rating of the tube set at 36 kV and 22mA.

The apparatus was carefully aligned and checked before mounting a sample. All the samples had the same exposure time of 8 hrs.

The samples were loaded into 0.5 mm diameter Lindemann glass tubes to be mounted in the Debye-Scherrer cameras. In the cameras Ilford Industrial 'G' X-ray film was used. The film was processed using Kodak DX-80 developer and Ilford Hypain fixer. The films were developed for 5 minutes using a 1:4 dilution for the developer and fixed for 2 minutes. The films were then washed in running water for 30 minutes and allowed to dry naturally. The X-ray films were then measured.

Using an illuminated screen and the line-spacings calculated, taking into account film shrinkage, from these line spacings the bragg angle and 'd' spacings can be calculated.

STANDARD PATTERNS

When all the samples X-ray photographs had been measured and the 'd' spacings calculated, they were visually inspected to find the film showing samples with pure mineral phases. These patterns were then taken as standards.

The samples were then broken up and the different mineral phases were sorted by hand to attempt to find a purer standard. These samples were then crushed in a similar way to the samples crushed beforehand. For X-ray analysis they were placed in 0.2 mm diameter tubes and given a 12 hr exposure. This method was used to give finer lines on the X-ray photograph and the larger exposure was to try and detect as many impurities as possible.

The 'd' spacings of the standards were compared with the A.S.T.M. index and also with themselves. They were compared with themselves to check that all the Talc and Chlorite standards matched each other and were similar in intensity.

Several standards were prepared containing the same mineral. This was because the 'd' spacings of the mineral varied slightly from sample to sample and especially with chlorite, depending on its composition the major reflections varied between 13.5% and 15.0%. This was mainly due to varying iron content and this can easily be seen on the X-ray films as it causes fluorescence with copper radiation and blackens the X-ray film generally.

RESULTS

For the analysis of the results the samples have been divided into five sections:

- (i) standard patterns
- (ii) sample patterns (rock type)
- (iii) sample patterns (carbonate type)
- (iv) sample patterns (talc type)
- (v) batch sample patterns (includes old powders and shipments).

Two methods were used to find the mineral present in the sample. One method uses a computer program to detect the mineral.

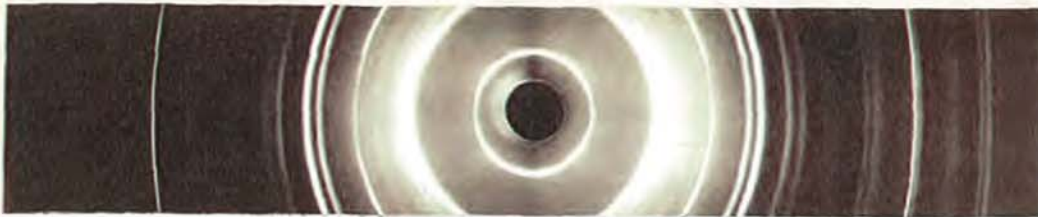
In this method the bragg angles of samples were compared with the bragg angles of the standard and the number of lines fitted printed out. A print out was also obtained of all the standards which fitted a particular line to find all the possible minerals present and to see which lines were common to several standards.

As this procedure is quite long, the lines in the sample were first sorted into order of decreasing intensity and then the three most intense lines of the sample compared with the standards. If all three lines failed to match it was considered that that standard was not present and so the program deleted that standard from the comparison. At the end of the program the list of the standards was printed with the percentage of lines fitted to the sample noted.

The obvious disadvantage of this comparison was that the program could take no account of the relative intensities of the lines and so a visual method was used to find which was the major mineral phase. The computer program usually found the mineral phases present in the samples but could not place them in the correct order.

Patterns used as standards from the
Italian mine samples and their
comparison with A.S.T.M. data and
against themselves.

SAMPLE SIP 1 TALC



Comparison against A.S.T.M. index: 1 line unmatched, 1.1145 Å⁰

Patterns not included: 6-263 Muscovite -2M1, 7-25

Muscovite (1M), 7-32 Muscovite (2M1), 7-76 Ripidolite (Chlorite), 7-78 Thuringite (Chlorite), 7-166 Bavalite (Chlorite), 10-183 Peninnite Chlorite, 11-78 Dolomite, B and T Quartz.

Most probable minerals present: Talc Muscovite Calcite

Comparison against Italian Standards

Patterns not included: Chlorite (I42), Chlorite (I4), Muscovite (I35), Magnesite (I6), Tremolite (I19/I20), Dolomite.

Most probable minerals present: Talc

Visual comparison

Talc, Calcite

Minerals detected

Talc, Calcite

SAMPLE SIP 2 TALC



Comparison against A.S.T.M. index: 2 lines unmatched, 1.1159 Å⁰
1.1353 Å

Patterns not included: 7-76 Ripidolite (Chlorite), 7-78 Thuringite (Chlorite), 7-166 Bavalite (Chlorite).

Most probable minerals present: Talc, Muscovite, Calcite

Comparison against Italian Standards

Patterns not included: Chlorite (I42), Chlorite (I4), Tremolite (I19/I20).

Most probable minerals present: Talc, Muscovite, Magnesite.

Visual Comparison

Talc, Chlorite, Magnesite

Minerals Detected

Talc, Chlorite, Magneitie

SAMPLE SIP 3 CHLORITE



Comparison against A.S.T.M. index: 2 lines unmatched, 1.1739 \AA ,
1.29 \AA

Patterns not included: 6-263 Muscovite -2M1, 7-25 Muscovite (IM)
7-32 Muscovite (2M1), 7-79 Forsterite (Olivine), 8-479 Magnesite

Most probable minerals present: Chlorite, Talc

Comparison against Italian Standards

Patterns not included: Muscovite (I35), Tremolite (I19 and I20)

Most probable minerals present: Chlorite, Talc.

Visual Comparison

Minerals Present

Chlorite, Talc

Chlorite, Talc

SAMPLE SIP 4 CHLORITE



Comparison against A.S.T.M. index: 3 lines unmatched
1.1741 \AA , 1.1318 \AA , 1.0984 \AA .

Patterns not included: 6-263 Muscovite -2M1, 7-32 Muscovite
(2M1), 8-479 Magnesite, 11-78 Dolomite, 13-437 Boric Acid.

Most probable minerals present: Chlorite, Talc

Comparison against Italian Standards

Patterns not included: Calcite (I34), Magnesite (I37),
Muscovite (I35), Tremolite (I19/I20), Dolomite.

Most probable mineral present: Chlorite, Talc

Visual Comparison

Minerals Present

Chlorite, Talc

Chlorite, Talc

SAMPLE SIP 5 TALC



Comparison against A.S.T.M. index:

Patterns not included: 5-586 Calcite, 7-25 Muscovite (IM),
7-77 Sheridanite (Chlorite), 7-79 Forsterite (Olivine),
7-166 Bavalite (Chlorite).

Most probable minerals present: Talc, Muscovite, Chlorite

Comparison against Italian Standards

Patterns not included: Chlorite (I42), Chlorite (I4),
Magnesite (I6), Tremolite (I19/I20).

Most probable minerals present: Talc

Visual comparison

Talc, Chlorite

Minerals Present

Talc, Chlorite

SAMPLE SIP 6 MUSCOVITE



Comparison against A.S.T.M. index: 3 lines unmatched, 1.7999^o_A,
1.3721^o_A, 1.2741^o_A.

Patterns not included: 3-881 Talc, 7-79 Forsterite (Olivine),
7-166 Bavalite (Chlorite), 7-183 Penninite (Chlorite),
8-479 Magnesite, 11-78 Dolomite, 19-770 Talc.

Most probable minerals present: Muscovite, Chlorite

Comparison against Italian Standards

Patterns not included: Magnesite (I37), Tremolite (I19 and I20),
Dolomite

Most probable minerals present: Muscovite, Talc

Visual Comparison

Muscovite, Calcite

Mineral Present

Muscovite, Calcite

SAMPLE SIP 7 MAGNESITE



Comparison against A.S.T.M. Index: 1 line unmatched 1.1092^o_A

Patterns not included: 5-586 Calcite, 6-263 Muscovite -2M1, 7-25 Muscovite (IM), 7-32 Muscovite (2M1), 7-160 Chlorite (Kotshubeite), 7-76 Ripodolite (Chlorite), 7-78 Thuringite (Chlorite), 7-166 Bavalite (Chlorite), 10-183 Penninite Chlorite, 13-437 Tremolite.

Most probable minerals present: Magnesite, Dolomite, Talc

Comparison against Italian Standards

Patterns not included: Calcite (I34), Chlorite (I4)
Muscovite (I35), Tremolite (I19/I20).

Most probable minerals present: Magnesite, Dolomite, Talc

Visual Comparison

Magnesite, Talc

Minerals Present

Talc, Magnesite.

SAMPLE SIP 8 TREMOLITE



Comparison against A.S.T.M. Index: 1 line unmatched 1.1118^o_A

Patterns not included: 6-263 Muscovite -2M1, 7-25 Muscovite (IM), 7-32 Muscovite (2M1), 7-42 Muscovite (3T), 7-79 Forsterite (Olivine).

Most probable minerals present: Tremolite, Talc, Calcite

Comparison against Italian Standards

Patterns not included: Magnesite (I37), Chlorite (I4),
Muscovite (I35).

Most probable minerals present: Tremolite, Talc, Calcite

Visual Comparison

Tremolite, Talc

Minerals Present

Tremolite, Talc

SAMPLE SIP 9 DOLOMITE



Comparison against A.S.T.M. Index: 1 line unmatched 1.1094⁰

Patterns not included: 3-881 Talc, 6-263 Muscovite -2M1, 7-25 Muscovite (IM), 7-32 Muscovite (2M1), 19-814 Muscovite 2M1 (Vanadian), 7-160 Chlorite (Kotschubeite), 7-79 Forsterite (Olivine), 13-437 Tremolite, 19-770 Talc.

Most probable minerals present: Dolomite, Muscovite

Comparison against Italian Standards

Patterns not included: Magnesite (I37), Chlorite (I4) Tremolite (I19/I20).

Most probable minerals present: Dolomite, Talc

Visual Comparison

Minerals Present

Dolomite, Muscovite, Calcite

Dolomite, Muscovite, Calcite

SAMPLE SIP 10 CALCITE



Comparison against A.S.T.M. Index: 3 unmatched lines
1.2095⁰, 1.1098⁰, 1.0926⁰

Patterns not included: 7-160 Chlorite (Kotschubeite), 7-79 Forsterite (Olivine), 13-437 Tremolite.

Most probable minerals present: Calcite, Muscovite

Comparison against Italian Standards

Patterns not included: Magnesite (I6), Tremolite (I19-I20).

Most probable minerals present: Calcite, Muscovite

Visual Comparison

Minerals Present

Calcite

Calcite, Muscovite

SAMPLE SIP 11 MAGNESITE



Comparison against A.S.T.M. Index: 1 unmatched line 1.1085⁰_A

Patterns not included: 5-586 Calcite, 7-25 Muscovite (IM),
7-160 Chlorite (Kotschubeite), 7-76 Ripidolite (Chlorite),
7-78 Thuringite (Chlorite), 7-166 Bavalite (Chlorite),
10-183 Penninite Chlorite, B & T Quartz.

Most probable minerals present: Magnesite, Dolomite, Talc

Comparison against the Italian Standards

Patterns not included: Calcite (I34), Chlorite (I4),
Muscovite (I35).

Most probable minerals present: Magnesite, Dolomite, Talc

Visual Comparison

Minerals Present

Magnesite, Dolomite, Talc

Magnesite, Talc, Dolomite

Examples of Patterns Obtained from
Rock Type Specimens and Their
Major Mineral Content from X-Ray
Comparison.

SAMPLE I1 TALC FROM FOOTWALL CONTACT

Comparison

Patterns not included: Magnesite (I37), Tremolite (I19/I20).

Most probable minerals present: Chlorite, Muscovite, Talc,
Dolomite.

Visual Comparison: Talc Chlorite, Calcite

Minerals Present: Talc Chlorite, Calcite.

SAMPLE I7 MICA SCHIST

Comparison

Patterns not included: Magnesite (I37), Talc (I46),
Tremolite (I19/I20).

Most probable minerals present: Muscovite, Talc, Quartz

Visual Comparison: Muscovite, Talc, Quartz

Minerals Present:

SAMPLE I12 FOOTWALL SAMPLE? AMPHIBOLITE

Comparison: 3 lines unmatched. 6.4653Å⁰ 1.2819Å⁰ 1.225Å⁰

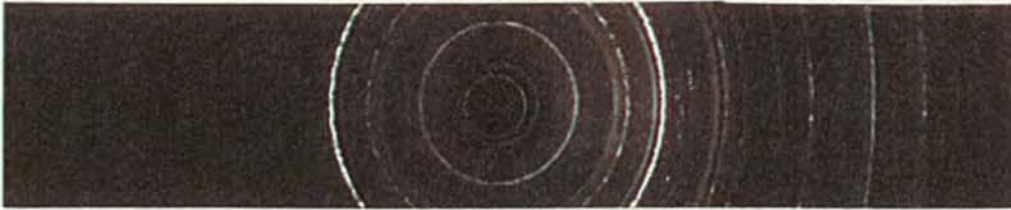
Patterns not included: Calcite (I34), Magnesite (I37),
Talc (I46), Talc (I5), Tremolite
(I19/I20).

Most probable minerals present: Muscovite, Dolomite, Quartz.

Visual Comparison: Muscovite, Chlorite, Quartz

Minerals Present:

SAMPLE I13 INCLUSION SHOWING PASSAGE INTO TALC BOTTOM TRANSIT



Comparison: 1 unmatched line 1.1541⁰_A

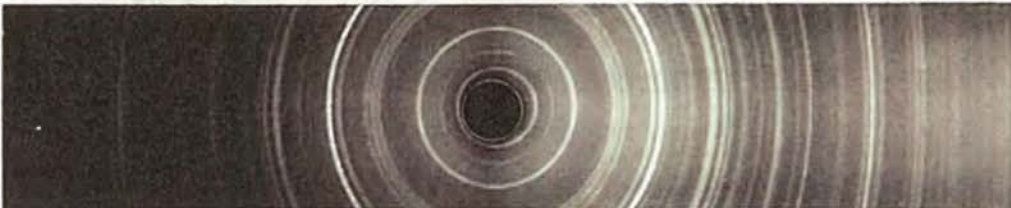
Patterns not included: Magnesite (I37), Muscovite (I35),
Tremolite (I19/I20), Dolomite

Most probable minerals present: Chlorite, Talc, Quartz

Visual Comparison: Chlorite, Muscovite, Quartz

Minerals Present: Chlorite, Muscovite, quartz

SAMPLE I15 TALC-FOOTWALL CONTACT



Comparison:

Patterns not included: Magnesite (I37), Tremolite (I19/I20).

Most probable minerals present: Chlorite, Talc, Muscovite,
Quartz.

Visual Comparison: Chlorite, Talc, Quartz

Minerals Present: Chlorite, Talc, Quartz

SAMPLE I16 FACE 1 INCLUSION BELOW SEAM

Comparison

Patterns not included: Talc (I45), Tremolite (I19/I20)
Dolomite

Most probable minerals present: Muscovite, Chlorite,
Calcite, Quartz

Visual Comparison: Chlorite, Muscovite, Calcite, Quartz

Minerals Present: Chlorite, Muscovite, Calcite, Quartz

SAMPLE I17 FOOTWALL ROCK SAMPLE



Comparison: 2 unmatched lines 6.6957\AA , 1.6305\AA

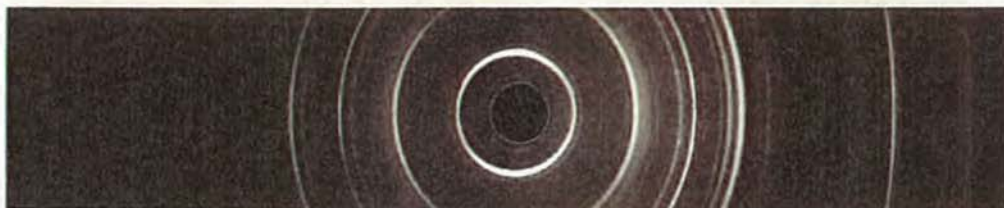
Patterns not included: Talc (I46), Chlorite (I42),
Muscovite (I35), Magnesite (I6), Tremolite (I19/I20), Dolomite.

Most probable minerals present: Calcite, Talc, Quartz

Visual Comparison: Calcite, Talc, Quartz

Minerals Present: Calcite, Talc, Quartz

SAMPLE I20 AMPHIBOLE SAMPLE FROM GUIANA LEVEL 1212



Comparison: 1 unmatched line 1.6309\AA

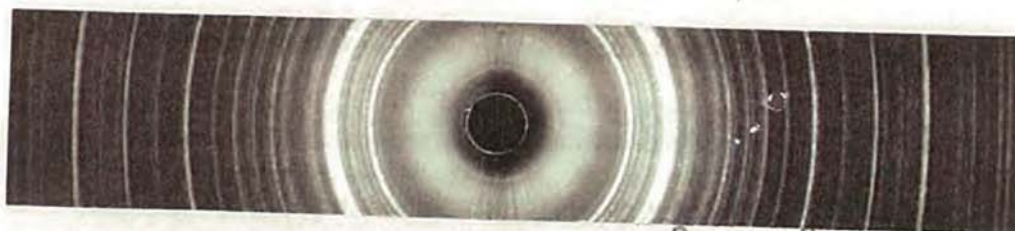
Patterns not included: Chlorite (I42), Chlorite (I4),
Muscovite (I35), Magnesite (I6), Dolomite.

Most probable minerals present: Talc, Tremolite, Calcite,
Magnesite.

Visual Comparison: Talc, Tremolite, Chlorite

Minerals Present: Talc, Chlorite, Tremolite

SAMPLE I23 BLACK GNEISS



Comparison: 5 unmatched lines 6.3586\AA , 1.449\AA , 1.2278\AA ,
 1.2121\AA , 1.1520\AA .

Patterns not included: Calcite (I34), Tremolite (I19/I20)

Most probable minerals present: Muscovite, Talc, Magnesite,
Quartz

Visual Comparison: Muscovite, Magnesite, Quartz

Minerals Present: Muscovite, Magnesite, Quartz

SAMPLE I25 LIMESTONE FOOTWALL

Comparison

Patterns not included: Calcite (I34), Tremolite (I19/I20).

Most probable minerals present: Talc, Chlorite, Quartz

Visual Comparison: Talc, Magnesite, Quartz

Minerals Present: Talc, Magnesite, Quartz

SAMPLE I27 LITHEOLOGICAL INCLUSION

Comparison

Patterns not included: Chlorite (I42), Chlorite (I4),
Tremolite (I19/I20), Magnesite (I6),
Dolomite

Most probable minerals present: Talc, Calcite, Quartz

Visual Comparison: Talc, Calcite, Quartz

Minerals Present: Talc, Calcite, Quartz

SAMPLE I29 SAMPLE 6 FOOTWALL

Comparison: 2 unmatched lines 1.1526A^o, 6.3031A^o

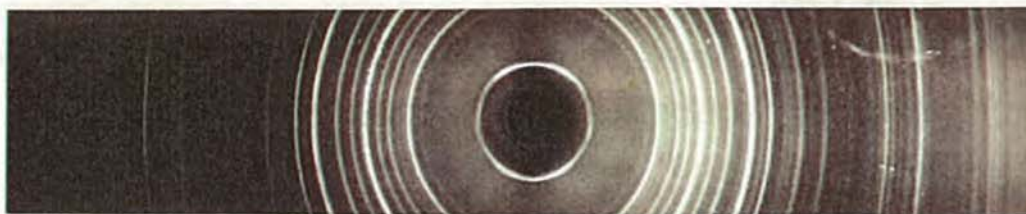
Patterns not included: Calcite (I34), Magnesite (I37),
Chlorite (I4), Talc (I5).

Most probable minerals present: Muscovite, Quartz, Dolomite,
Talc

Visual Comparison: Muscovite, Quartz

Minerals Present: Muscovite, Quartz

SAMPLE I31 BLACK INCLUSION



Comparison: 1 unmatched line 1.2145Å⁰

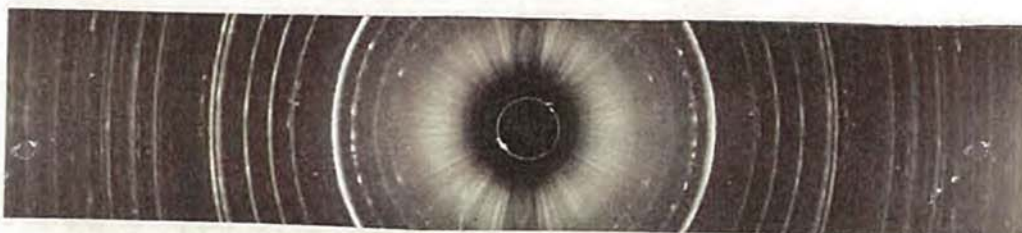
Patterns not included: Magnesite (I37), Talc (I5), Dolomite

Most probable minerals present: Muscovite, Calcite, Talc

Visual Comparison: Muscovite, Calcite

Minerals Present: Muscovite, Calcite

SAMPLE I34 TUNNEL WALL - MARBLE



Comparison

Patterns not included: Tremolite (I19/I20), Magnesite (I6)

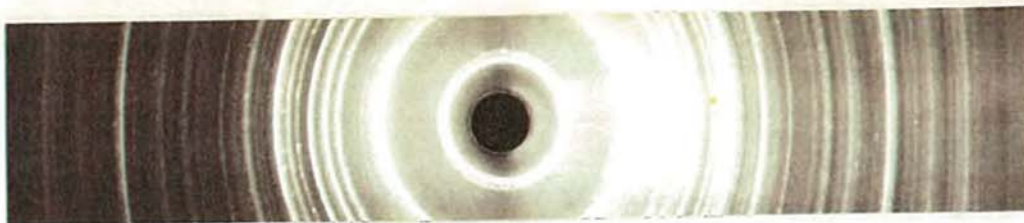
Most probable minerals present: Calcite, Muscovite, Talc

Visual Comparison, Calcite

Minerals Present Calcite

Examples of Patterns Obtained
from the Carbonate Specimens
and their Major Mineral Compo-
sition Obtained from Comparison
with Standards.

SAMPLE I4 FACE 10 AMPHIBOLE



Comparison: 3 unmatched lines 1.2596\AA , 1.0823\AA , 1.074\AA

Patterns not included: Chlorite (I42), Chlorite (I4)
Dolomite

Most probable minerals present: Tremolite, Talc, Magnesite

Visual Comparison: Talc, Tremolite, Magnesite

Minerals Present: Talc, Tremolite, Magnesite

SAMPLE I6 QUARTZ

Comparison

Patterns not included: Calcite (I34), Chlorite (I4)
Tremolite (I19/I20)

Most probable minerals present: Magnesite, Dolomite,
Talc

Visual Comparison: MAGNESITE, Talc

Minerals Present: Magnesite, Talc

SAMPLE I11 CARBONATE - TALC INCLUSION



Comparison: 1 unmatched line 1.2143⁰_A

Patterns not included: Chlorite (I42), Chlorite (I4)

Most probable minerals present: Magnesite, Dolomite, Talc

Visual Comparison: Talc, Magnesite, Calcite

Minerals Present: Talc, Magnesite, Calcite

SAMPLE I14 SEAM 4 INCLUSION IN TALC

Comparison

Patterns not included: Magnesite (I37), Chlorite (I4),
Muscovite (I35), Tremolite (I19/I20)

Most probable minerals present: Dolomite, Talc

Visual Comparison: Talc, Dolomite

Minerals Present: Talc, Dolomite

SAMPLE I18 FACE 3 MAGNESITE AND TALC

Comparison:

Patterns not included: Talc (I5), Tremolite (I19/I20)

Most probable minerals present: Dolomite, Magnesite,
Chlorite

Visual Comparison: Dolomite, Talc Chlorite

Minerals Present: Dolomite, Talc, Chlorite.

SAMPLE I 19 IMPURITY IN TALC AND QUARTZ



Comparison:

Patterns not included: Magnesite (I37)

Most probable minerals present: Tremolite, Dolomite,
Muscovite, Talc

Visual Comparison: Talc, Tremolite, Magnesite.

Minerals Present: Talc, Tremolite, Magnesite

SAMPLE I21 FACE 2 OCCLUSION (MAGNESITE)



Comparison:

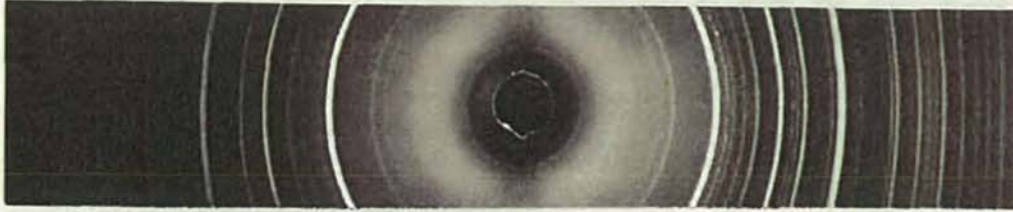
Patterns not included: Calcite (I34), Chlorite (I4),
Muscovite (I35), Tremolite (I19/I20)

Most probable minerals present: Dolomite, Magnesite, Talc

Visual Comparison: Talc, Magnesite, Dolomite

Minerals Present: Talc, Magnesite, Dolomite

SAMPLE I22 MAGNESITE, DOLOMITE, TALC



Comparison:

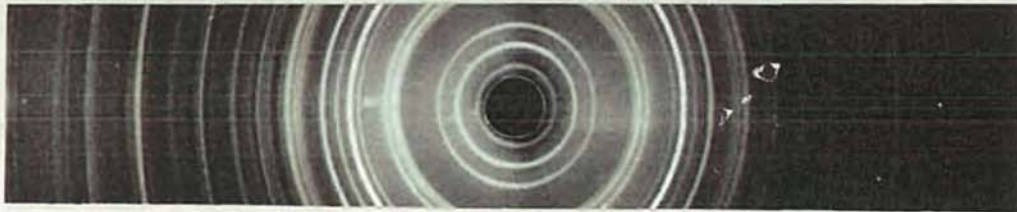
Patterns not included: Calcite (I34), Talc (I45), Talc (I46)
Muscovite (I35), Tremolite (I19/I20).

Most probable minerals present: Dolomite, Magnesite,
Chlorite, Talc.

Visual Comparison: Talc, Dolomite.

Minerals Present: Talc, Dolomite

SAMPLE I30 TALC AND OTHERS



Comparison:

Patterns not included: Magnesite (I37), Talc (I5),
Tremolite (I19/I20).

Most probable minerals present: Dolomite, Chlorite,
Muscovite, Talc.

Visual Comparison: Talc, Chlorite

Minerals Present: Talc, Chlorite

SAMPLE I35 MASSIVE CARBONATE. END OF WORKING



Comparison:

Patterns not included: Tremolite (I19/I20).

Most probable minerals present: Muscovite, Magnesite, Chlorite

Visual Comparison: Magnesite, Talc, Chlorite

Minerals Present: Magnesite, Talc, Chlorite

SAMPLE I37 CARBONATE AND TALC



Comparison

Patterns not included: Calcite (I34), Chlorite (I4),
Muscovite (I35).

Most probable minerals present: Magnesite, Dolomite, Talc

Visual Comparison: Magnesite, Talc

Minerals Present: Magnesite, Talc

Examples of Patterns and
Major Mineral Content of
Those Specimens Classified
as Talc Types Obtained by
Comparison.

SAMPLE I2 SORTING PIECES



Comparison

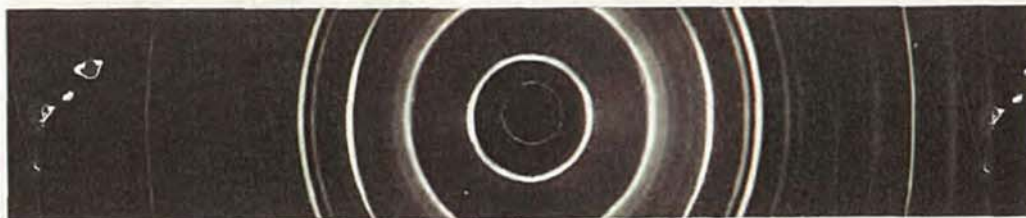
Patterns not included: Tremolite (I19/I20)

Most probable minerals present: Chlorite, Magnesite, Talc

Visual Comparison: Chlorite, Talc

Minerals Present: Chlorite, Talc

SAMPLE I3 COLOURED TALC



Comparison:

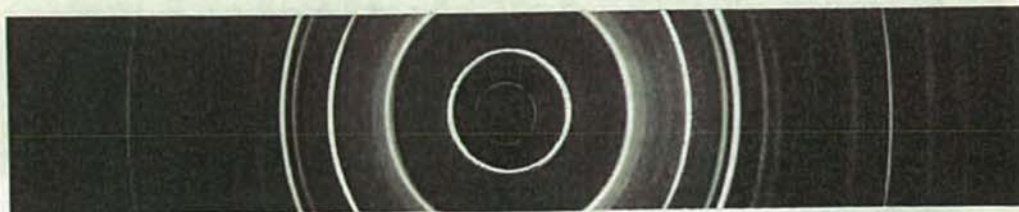
Patterns not included: Chlorite (I42), Chlorite (I4),
Muscovite (I35), Magnesite (I6), Tremolite (I19/I20), Dolomite.

Most probable minerals present: Talc

Visual Comparison: Talc

Minerals present: Talc

SAMPLE I5 GENERAL ONE



Comparison: 2 unmatched lines 18.1157^o 7.0073^o

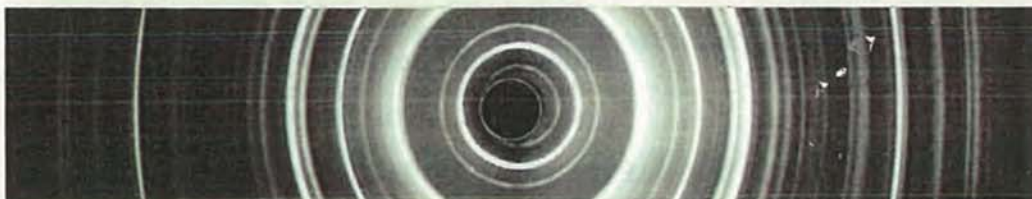
Patterns not included: Chlorite (I42), Chlorite (I4),
Muscovite (I35), Dolomite.

Most probable minerals present: Talc, Magnesite

Visual Comparison: Talc

Minerals present: Talc

SAMPLE I8 MASSIVE TALC



Comparison

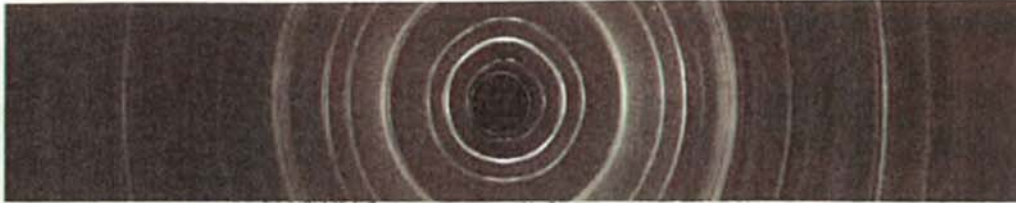
Patterns not included: Magnesite (I6), Tremolite (I19/I20).

Most probable minerals present: Talc, Chlorite

Visual Comparison: Talc, Chlorite

Minerals Present: Talc, Chlorite

SAMPLE I9 FACE 1 GREY TALC



Comparison

Patterns not included: Calcite (I34), Magnesite (I37),
Muscovite (I35), Magnesite (I6), Tremolite (I19/I20).

Most probable minerals present: Talc, Chlorite

Visible Comparison: Talc, Chlorite

Minerals Present: Talc, Chlorite

SAMPLE I10 GRANULAR TALC

Comparison

Patterns not included: Calcite (I34), Magnesite (I37),
Chlorite (I42) Chlorite (I4),
Muscovite (I35), Magnesite (I6)
Tremolite (I19/I20)

Most probable minerals present: Talc, Dolomite

Visible Comparison: Talc, Dolomite

Minerals Present: Talc, Dolomite

SAMPLE I24 TALC FACE #



Comparison:

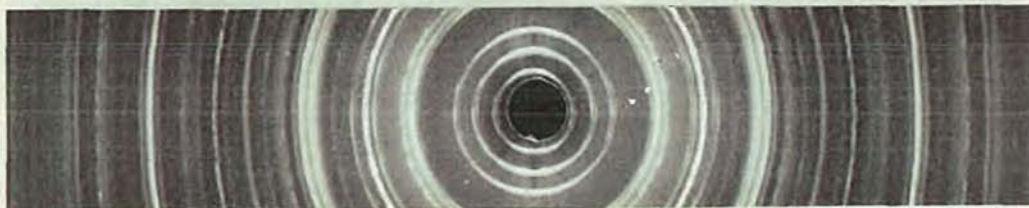
Patterns not included: Muscovite (I35), Tremolite (I19/I20)
Magnesite (I6).

Most probable minerals present: Talc, Chlorite, Dolomite,
Magnesite

Visual Comparison: Dolomite, Magnesite, Talc

Minerals Present: Dolomite, Magnesite, Talc

SAMPLE I26 TALC INCLUSIONS



Comparison

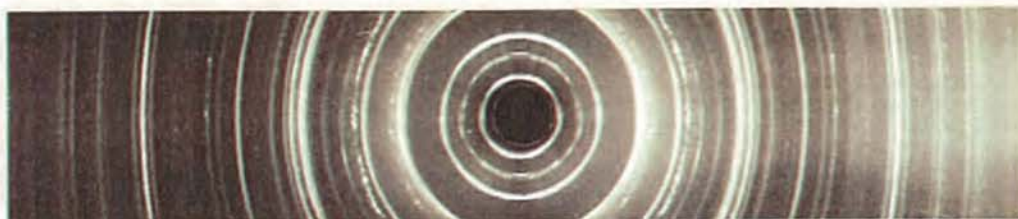
Patterns not included: Calcite (I34), Tremolite (I19/I20)

Most probable minerals present: Talc, Chlorite, Dolomite

Visual Comparison: Talc, Chlorite

Minerals Present: Talc, Chlorite

SAMPLE I28 QUARTZ TALC



Comparison

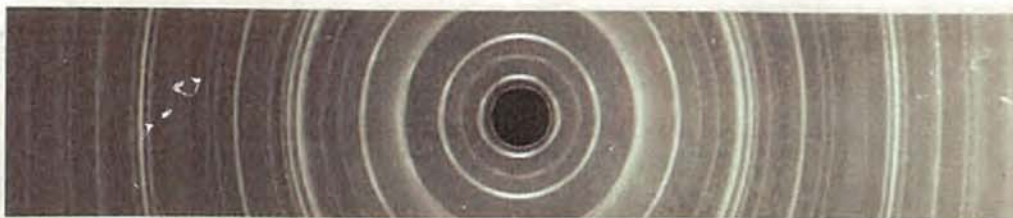
Patterns not included: Muscovite (I35), Tremolite (I19/I20)
Magnesite (I6), Dolomite

Most probable minerals present: Chlorite, Talc, Quartz

Visual Comparison: Chlorite, Talc, Quartz

Minerals Present: Chlorite, Talc, Quartz

SAMPLE I32 OCCLUSION FACE 2



Comparison

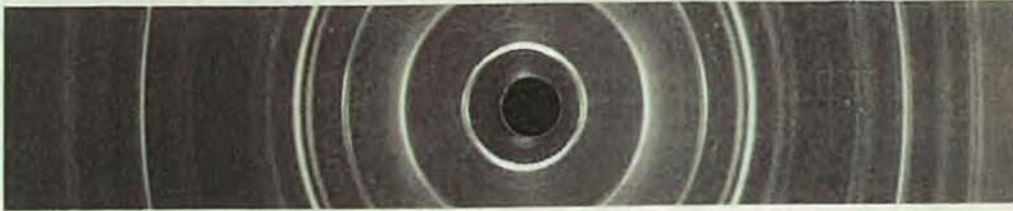
Patterns not included: Muscovite (I35), Tremolite (I19/I20)
Dolomite

Most probable minerals present: Chlorite, Talc, Magnesite

Visual Comparison: Chlorite, Talc

Minerals Present: Chlorite, Talc

SAMPLE I33 TALC END OF WORKING



Comparison:

Patterns not included: Muscovite (I35), Tremolite (I19/I20)

Most probable minerals present: Talc, Chlorite, Magnesite
Dolomite

Visual Comparison: Talc, Chlorite, Magnesite

Minerals Present: Talc, Chlorite, Magnesite

SAMPLE I36 GREY TALC

Comparison: 2 unmatched lines 1.2204\AA ; 1.1517\AA

Patterns not included: Calcite (I34), Talc (I46)
Tremolite (I19/I20).

Most probable minerals present: Chlorite, Muscovite, Talc

Visual Comparison: Chlorite, Talc

Minerals Present: Chlorite, Talc

SAMPLE I38 TALC AND PYRITE

Comparison: 1 unmatched line 1.041\AA

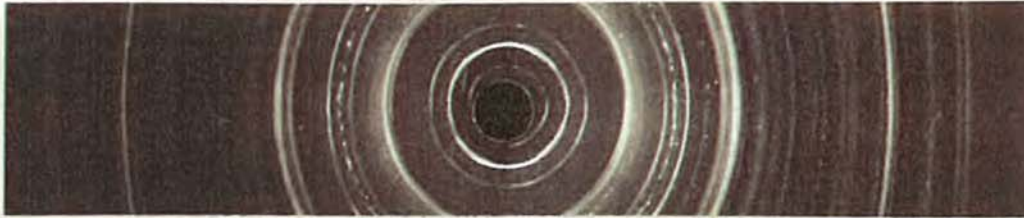
Patterns not included: Chlorite (I42), Chlorite (I4),
Muscovite (I35), Tremolite (I19/I20)

Most probable minerals present: Talc, Calcite

Visual Comparison: Talc, Calcite

Minerals Present: Talc, Calcite

SAMPLE I39 S-'Q' FROM CRUSHER



Comparison

Patterns not included: Muscovite, (I35), Tremolite (I19/I20),
Magnesite (I6).

Most probable minerals present: Talc Chlorite

Visual Comparison: Talc, Chlorite, Calcite

Minerals Present: Talc, Chlorite, Calcite

SAMPLE I40 PLATEY TALC

Comparison:

Patterns not included: Tremolite (I19/I20)

Most probable minerals present: Talc, Magnesite, Chlorite

Visual Comparison: Talc, Chlorite, Magnesite

Minerals Present: Talc, Chlorite, Magnesite

SAMPLE I41 GOOD SPECIMEN No.2.

Comparison:

Patterns not included: Calcite (I34), Muscovite (I35),
Tremolite (I19/I20), Magnesite (I6),
Dolomite

Most probable minerals present: Talc, Chlorite

Visual Comparison: Talc, Chlorite

Minerals Present: Talc, Chlorite

SAMPLE I42 COLOURED TALC No.1.



Comparison

Patterns not included: Magnesite (I37), Talc (I46), Muscovite (I35), Dolomite.

Most probable minerals present: Chlorite, Talc

Visual Comparison: Chlorite, Talc

Minerals Present: Chlorite, Talc

SAMPLE I43 FIBROUS TALC FACE 10



Comparison: 2 unmatched lines 4.8928\AA , 4.4431\AA

Patterns not included: Calcite (I34), Magnesite (I37),
Muscovite (I35), Tremolite (I19/I20)

Most probable minerals Present: Chlorite, Talc

Visual Comparison: Chlorite, Talc

Minerals Present: Chlorite, Talc

SAMPLE I44 PURE TALC FACE 1

Comparison: 1 unmatched line 1.0798

Patterns not included: Magnesite (I37), Talc (I42),
Muscovite (I35), Tremolite (I19/I20)

Most probable minerals present: Chlorite, Talc, Dolomite

Visual Comparison: Talc, Magnesite, Chlorite

Minerals Present: Talc, Magnesite, Chlorite

SAMPLE I45 GOOD SPECIMEN FACE 1



Comparison: 2 unmatched lines 1.0882A, 1.0505A

Patterns not included: Calcite (I34), Chlorite (I42), Chlorite (I4)
Muscovite (I35), Magnesite (I6), Tremolite (I19/I20), Dolomite.

Most probable minerals present: Talc, Magnesite

Visual Comparison: Talc

Minerals Present: Talc

SAMPLE I46 COLOURED TALC FACE 3



Comparison:

Patterns not included: Chlorite (I42), Chlorite (I4), Muscovite
(I35), Tremolite (I19/I20).

Most probable minerals present: Talc, Magnesite

Visual Comparison: Talc, Magnesite

Minerals Present: Talc, Magnesite

Specimen Patterns and Comparison Data for
Samples of Old Powders and ~~00000~~ Shipments

SAMPLE BATCH 6 POWDER F1 PW.J. 035

Comparison: 1 unmatched line 8.1972^o_A

Patterns not included: Muscovite (I35), Tremolite (I19/I20)

Most probable minerals present: Talc, Magnesite, Chlorite

Visual Comparison: Talc, Chlorite, Magnesite

Minerals Present: Talc, Chlorite, Magnesite

SAMPLE BATCH 8 POWDER (S and G) PW.J. 035



Comparison

Patterns not included: Magnesite (I6), Tremolite (I19/I20)

Most probable minerals present: Talc, Magnesite, Boric Acid

Visual Comparison: Talc, Chlorite, Boric Acid

Minerals Present: Talc, Chlorite, Boric Acid

SAMPLE BATCH 9 POWDER T4 P.W.J. 035

Comparison: 1 unmatched line 1.2587^o_A

Patterns not included: Tremolite (I19/I20)

Most probable minerals present: Talc, Chlorite, muscovite,
Magnesite, Boric Acid

Visual Comparison: Talc, Chlorite, Boric Acid

Minerals Present: Talc, Chlorite, Boric Acid

SAMPLE BATCH 10 POWDER SK1BP PW.J. 035

Comparison

Patterns not included: Calcite (I34), Muscovite (I35),
Tremolite (I19/I20), Dolomite

Most probable minerals present: Talc, Chlorite, Magnesite,
Boric Acid.

Visual Comparison: Talc, Chlorite, Boric Acid

Minerals Present: Talc, Chlorite, Boric Acid

SAMPLE BATCH 11 POWDER LD18P PW.J. 035



Comparison: 1 unmatched line 8.1363\AA

Patterns not included: Magnesite (I6), Tremolite (I19/I20)
Dolomite

Most probable minerals present: Talc, Chlorite, Boric Acid

Visual Comparison: Talc, Chlorite, Boric Acid, Magnesite

Minerals Present: Talc, Chlorite, Boric Acid, Magnesite

SAMPLE BATCH 12 TALC 1960 PW.J. 025

Comparison: 1 unmatched line 8.12\AA

Patterns not included: Tremolite (I19/I20)

Most probable minerals present: Talc, muscovite, chlorite,
Boric Acid.

Visual Comparison: Talc, Chlorite, Boric Acid, Magnesite

Minerals Present: Talc, Chlorite, Boric Acid, Magnesite

SAMPLE BATCH 13 TALC 1961 PW.J. 026

Comparison

Patterns not included: Calcite (I34), Muscovite (I35)
Tremolite (I19/I20)

Most probable minerals present: Talc, Chlorite, Magnesite
Boric Acid

Visual Comparison: Talc, Chlorite, Magnesite, Boric Acid

Minerals Present: Talc, Chlorite, Magnesite, Boric Acid

SAMPLE BATCH 19 S.S. CATHERINA W. 02/05/72



Comparison

Patterns not included: Tremolite (I19/I20)

Most probable minerals present: Talc, Chlorite, Magnesite

Visual Comparison: Talc, Chlorite, Magnesite

Minerals Present: Talc, Chlorite, Magnesite

SAMPLE BATCH 2 TALC S.S. EDNA 'B' 14/02/72

Comparison

Patterns not included: Talc (I45), Tremolite (I19/I20)

Most probable minerals present: Talc, Chlorite

Visual Comparison: Talc, Chlorite

Minerals Present: Talc, Chlorite

CONCLUSIONS

The optical examination has shown that there are a large number of minerals associated with the rock types found both in the talc seam and in the associated rocks. The footwall rocks in contact with the talc are mainly composed of the minerals quartz, muscovite, chlorite, garnet, and some carbonate material both calcite and magnesite. Minor minerals in the footwall contact rocks include epidote, microcline, tremolite and actinolite, sphene, rutile, hornblende, rare talc, biotite, pyrite, pyrrhotite and chalcopyrite. Rock type inclusions into the talc have similar compositions to the footwall rocks but with higher muscovite and chlorite contents. The muscovite was generally an iron rich variety (phengite), while two forms of chlorite were observed namely sheridanite and penninite. Other talc inclusions consist mainly of carbonate minerals, calcite and magnesite in varying quantities. It is with these nodules that some tremolite is found. The rocks further away from the talc seams, namely the gneiss, become richer in quartz and microcline and below these marble occurs.

The carbonate specimens examined by optical means showed that the carbonate minerals, calcite and magnesite, were accompanied by talc, chlorite, tremolite, muscovite, rutile and pyrite, all in minor amounts. In general the carbonate inclusions were large and very discrete in the talc seam itself.

The specimens examined, which can be classified as talc samples, were found to be in the main composed of talc with chlorite as the major contaminant. Some specimens, however, were predominantly composed of chlorite with minor talc inclusions. Other minerals found in association with the talc specimens included garnet, rutile and magnesite with rare tremolite and a quartz or serpentine inclusion. Some differences were observed in the talc itself, some of the talc appearing to be a little murky in texture. X-ray pictures of the clear and murky material showed no differences however.

The powder X-ray examination confirmed the major minerals occurring in the hand specimens and a classification was possible into the three groups already mentioned, i.e. rock types, carbonate samples and talc specimens. The only asbestos type mineral to be detected in the hand samples was tremolite, which was found in three of the specimens. The tremolite was associated with carbonate minerals, namely magnesite and calcite, no tremolite was detected in the talc type specimens. Chlorite was, however, very common in the talc types, some of the specimens being very nearly pure chlorite in composition. There appeared to be some association of the chlorite with coloured talc specimens, especially those with a greyish colour. Other colour variations due to rutile were not detected by X-ray examination.

The examination of consecutive samples at face 1 in the mine showed that the chlorite content can vary very drastically over a 6ft thick section of the talc seam. Patterns obtained from several shipments of ~~ppppp~~ talc showed that chlorite, together with carbonate material, were the major contaminant minerals. This was also true of powder samples ranging back to 1949 in which the only observable difference was the presence of boric acid.

The electron microscope examination of the powdered samples showed that a difference could be drawn between particles produced from the various samples. The carbonates and rock types on the whole produced compact fibre free particles. The talc specimens were, however, plate-like in appearance with varying quantities of lath like particles coupled with fibres which were textile in appearance. Both lath and textile types of particles were not composed of minerals associated with the commercial asbestos industry. Particles formed from the amphibole mineral found at the mine were hardly fibrous in character, the majority of the tremolite breaking to give compact particles. Those fibres formed were short and had a very large diameter when compared with the commercial varieties of asbestos. No amphibole or chrysotile mineral was detected in any of the numerous powders examined.

The Italian talc ~~ppppp~~ contains observable quantities of chlorite and carbonate minerals and could contain any one of the following minerals in very minor amounts: muscovite, quartz, tremolite, garnet and rutile. If small pieces of footwall rock were to contaminate the ore during production, several of the other listed minerals found in the rock type specimens could appear in the shipped product. It is unlikely that they would be present in detectable amounts.

F.D. POOLEY
Project Supervisor